APRIL 27, 1959

Price 50 cents

DESIGN issue

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

Stainless grows whiskers... *see page 5*

VALUE ANALYSIS where it really counts ... during design!

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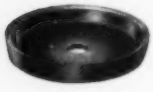
C/R Standard End Face Seal

C/R Sirvene Diaphragm



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If the operator follows instructions, then two three-way valves, either in series or in parallel, can protect his hands to a degree; but the *operator* who sets his mind to it, can beat either of these hook-ups and keep one hand free. This valve is designed to avoid one hand operation. In the Ross non-tie-down circuit, both three-way button valves are depressed at once to initiate an action and both released before another action can be initiated.

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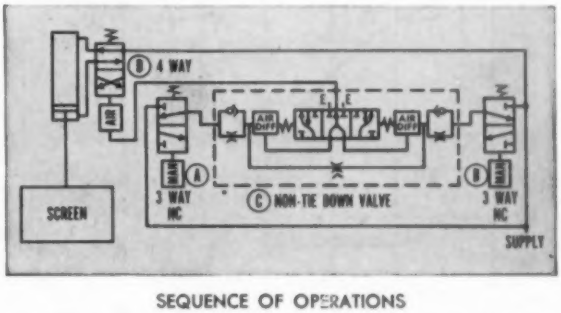

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- De-actuating valves "A" and "B" simultaneously de-actuates valves "C" and "D". Cylinder retracts and valve "C" re-sets itself for another cycle.
- Operating either valve "A" or "B" independently will *not* cause valve "C" to pass actuating air to valve "D".
- De-actuating either valve "A" or "B" independently, causes pilot air to valve "D" to be exhausted through valve "C". After that occurs both valves "A" and "B" must be released to re-set valve "C" before it will pass air to valve "D" again.

ROSS OPERATING VALVE CO.

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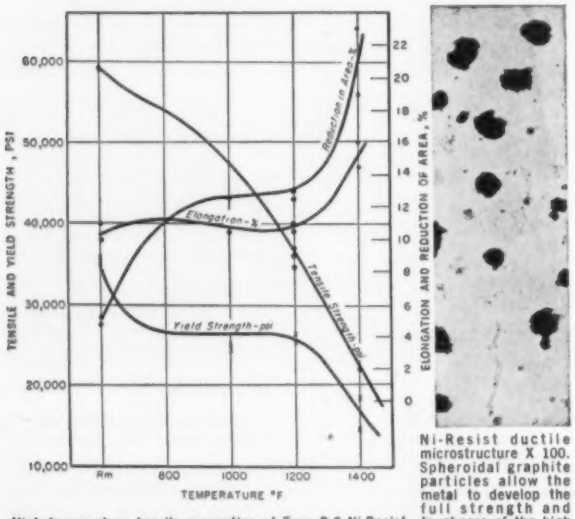
Corrosion resistance Ni-Resist ductile irons safely handle hundreds of corrosives. Under most conditions – with acids, alkalies and salts – their performance is far superior to both cast iron and steel, helping you reduce maintenance costs.



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Ni-Resist ductile microstructure X 100. Spheroidal graphite particles allow the metal to develop the full strength and toughness of the high alloy austenitic matrix.

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Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN RESEARCH AND DEVELOPMENT

DESIGN issue

April 27, 1959 Vol. 30, No. 17

DEPARTMENTS:

INTERESTING TO NOTE 5
DEVELOPMENTS TO WATCH 19
THE ENGINEERING WEEK 21
COMING EVENTS 25
READER TO EDITOR 26
DESIGN PERSPECTIVES 45
HORIZONS 47
PRODUCT DESIGNS 54
SIGNIFICANT COMPONENTS 75
CATALOGS AND BULLETINS 92
DESIGN ABSTRACTS 107
NEW BOOKS 110
CURRENT REPRINTS 119

FEATURED:

TESTS OXIDATION OF SUPERALLOYS . . . *Rod Simenz, Boeing Airplane Co*
New technique uses subsurface damage as clue to performance 48

NONMETALS FOR BUILT-IN CONVEYORS . . . *A R Gardner, associate editor*
Their advantages as belt materials; how to specify them 51

DESIGNING SPUN PARTS . . . *F J Covelli, Comc'l Shearing & Stamping Co*
Basic shapes and complicated ones—how to put more into them. 58

PIEZOELECTRIC TRANSDUCERS . . . *J J Siegel, Avco Manufacturing Co*
How to measure fluctuating forces, pressures, accelerations 61

ADHESIVES STACK LAMINATIONS. . . *R E George, Gebe Electronic Services*
Process gives better bonding, doesn't need rivets or welds 63

TABULAR METHOD FOR DYNAMICS . . *E E Ungar; Bolt Beranek & Newman Inc*
Numerical integration will even analyze a rocket's flight 64

12 WIRE GUIDES . . . *F W Wood Jr, Vitro Laboratories*
They will also work with rope, thread and cable 68

SHAPE OF PIN-CONNECTED LINKAGES . . . *Potts & Liddicoat, Univ of Michigan*
Graphic method is for symmetrical arrangements—4 or 5 links 71

FIELDS OF INTEREST REPRESENTED IN DEPARTMENTS:

MATERIALS:
Urethane coatings dry faster in new formula. 20
Foamed plastic gives smoke for reflecting radio waves. 19
New brazing methods boost production of stainless honeycomb sandwiches . 23

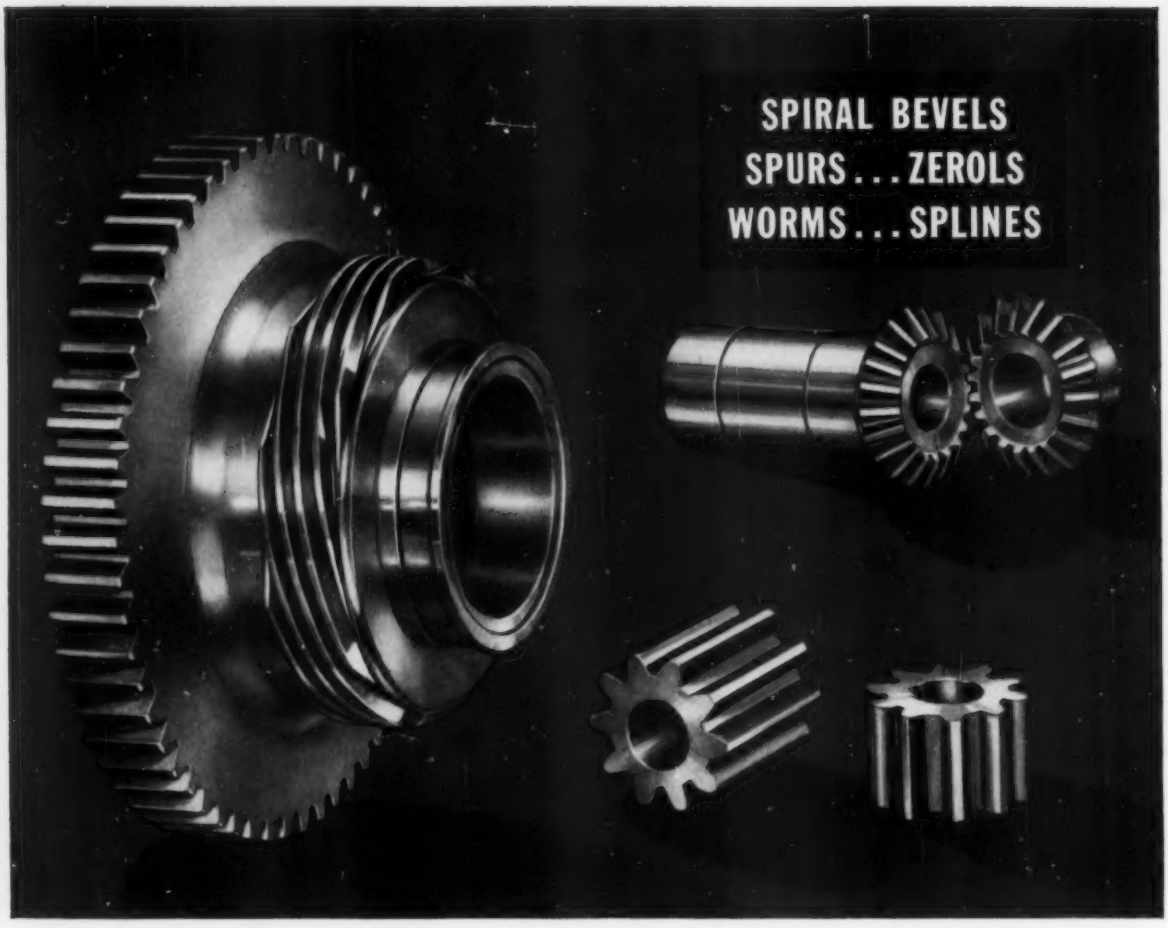
MECHANICAL:
With special spring, O-ring won't pop out. 20
Non-aircraft uses are sought for gas turbines. 22

ELECTRICAL:
Shaft-driven electrical control has magnetic contacts. 75
Transistors vs tubes—a quick, up-to-date appraisal 20
Timer programs power supplies in sequence. 75

PRODUCT DESIGN:
Originality spells success for foreign cars in International Auto Show 54
Safety light gets power from its own turbo-generator. 19

TEST:
Oxidation is measured in angstroms—our cover story 5
Stroboscopic vibration analyzer designed for work in missile industry 22

GENERAL:
Refresher courses for engineers—this summer's offerings 24
The two Germanys and their rival fairs: Leipzig and Hannover. 45
And Mercedes was her name—the evolution of racing cars 7



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Interesting to Note . . .

On the Surface of Stainless

With the increased interest in space, we've noted an influx of space maps. For example, a cartographer recently published an up-to-date moon map complete with photographs. One of the early space mappers, Anders J. Angstrom, also pioneered in spectroscopy. A 19th century Swede, Angstrom discovered hydrogen on the sun while mapping the solar spectrum. Years later, his name was adopted as the unit employed in measuring wavelengths of light, being equal to one ten-millionth of a millimeter (1×10^{-10} meter).

The usefulness of so small a unit is seen on our cover. The photo shows the edge of a stainless steel wire at 30,000 magnifications after reaction with oxygen at 600 C for 24 hours under stress. Many thin-iron and chromium oxide platelets form on a small area of the specimen. These platelets are about 100 angstroms thick, 40,000 angstroms high and 40,000 angstroms long. Without stress, these bursts of oxide are not formed.

These oxide platelets are formed only when the nucleation sites for chemical reaction are in an ordered arrangement. This experiment suggests that internal and external stress, precipitates, impurities, and hydrogen tend to line up the nucleation sites so the linear type of chemical reaction will occur. Such chemical reaction is tantamount to cutting the metal on a submicroscopic scale and may furnish sites for stress-corrosion cracking.

Hi-Ho, Come to the Fair

One of the first outgrowths of barter and trade was the local custom of having fairs. At first a fair was simply the opportunity for a town's bazaar or market place to have what we know today as a "sale"; customers from neighboring towns were invited to spend their money. As the means for communicating improved, fairs became larger and drew more people. Soon, amusements were added to attract more customers and by the 17th century the "pleasure fair" began to assume more importance than the commercial fair. Amusements soon outnumbered the merchants' stalls.

In 18th century England, another type sprang up—the "mop" fair. At Stratford-on-Avon, domestic and farm laborers would display themselves in hopes that farmers would hire them for the following year. Each worker would carry an emblem of his trade;

(CONTINUED ON PAGE 7)

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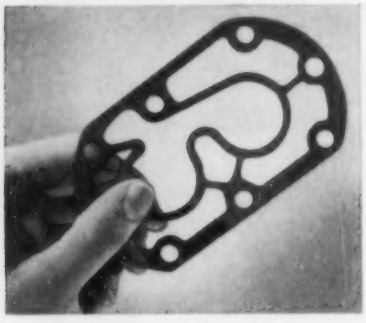
Technical data for gasket design and selection

Choosing a gasket for compressors

In selecting a gasket material for a compressor head, the first consideration is the gasket's ability to withstand the usual ambient temperature of about 300° F.



At such elevated temperatures, and with internal pressures ranging well over 100 psi, torque retention becomes another critical factor.

In the case of refrigerator compressors, the choice of a gasket is further limited by the presence of refrigerant gases which attack many materials.

A material that meets these requirements is Accopac AN-890, a new beater-saturated gasket material pioneered by Armstrong. Accopac AN-890 is a blend of refined asbestos fibers with a nitrile-type rubber binder.

AN-890 withstands temperatures up to 800° F. Its nitrile-type rubber binder swells slightly in the presence of refrigerant gases. Since these gases do not deteriorate AN-890, the swelling acts to maintain a tight seal.

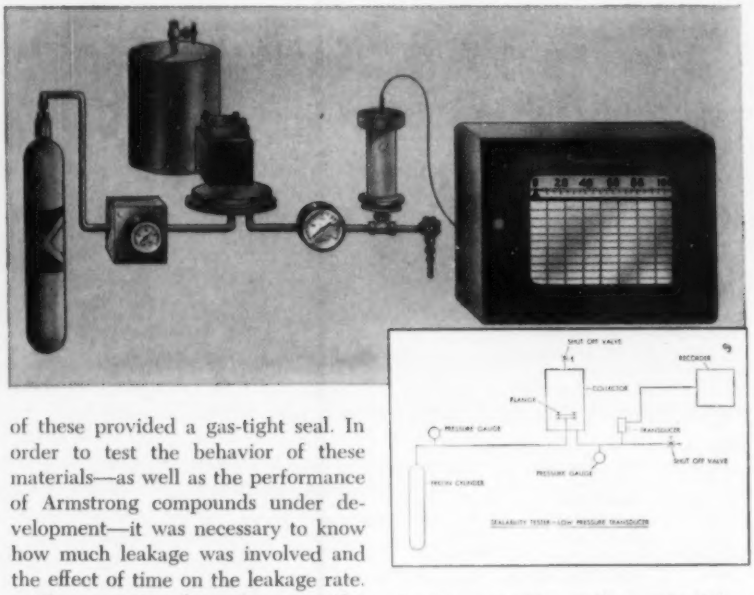
Bolt torque retention of Accopac AN-890 has been proved by comparing a flange containing refrigerant gas at 350° F. and 150 psi, and a control flange at room temperature and no gas. Accopac maintained bolt torque equally well in both flanges.

Send for a copy of the new Armstrong Gasket Design Manual. Write on your business letterhead to Armstrong Cork Company, 7104 Irvin Street, Lancaster, Pennsylvania.

Testing the sealing characteristics of refrigeration compressor gaskets

Sealing a refrigerator compressor can be a tough gasket problem. The effects of elevated temperature and high internal pressure are aggravated by the tendency of refrigerants to attack some gasket materials.

In developing an improved gasket for compressors, Armstrong research engineers tested commercially available materials. They found that none of these provided a gas-tight seal. In order to test the behavior of these materials—as well as the performance of Armstrong compounds under development—it was necessary to know how much leakage was involved and the effect of time on the leakage rate.



The apparatus shown here provides such information. FREON* refrigerant under 128 psi at 72° F. is piped to a gasketed compressor flange covered by a sealed collector. Leakage is sensed by a transducer as an increase in pressure in the collector. The increases are continuously recorded.

With this apparatus, the effect on gasket materials of such gases as FREON refrigerant can be observed and evaluated. As one example, it is known that this gas has a pronounced swelling effect on unconfined samples of gasket materials that contain nitrile-type rubber. In this device, however, materials are tested under normal compression, and tests show that the swelling effect of the FREON improves the sealing efficiency of the gasket.

As a result of such testing, Armstrong has developed a new high-density asbestos gasket material—Accopac AN-890. This new product seals better than some conventional materials, and it offers a cost saving of from 15% to 30%.

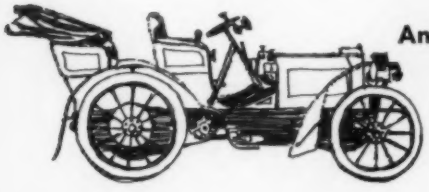
At Armstrong, research on problems of gasket design, selection, and performance is a full-time activity. This work may be of help in solving a sealing problem for you. We'll be glad to make suggestions if you send details to us.

*FREON AND COMBINATIONS OF FREON- AND F- WITH NUMERALS ARE REGISTERED TRADE-MARKS OF THE E. I. DU PONT DE NEMOURS & CO., INC., FOR ITS FLUORINATED HYDROCARBON REFRIGERANTS.

Armstrong GASKET MATERIALS

. . . used wherever performance counts

a maid would carry a mop, a shepherd some wool. By the 19th century, fairs acquired a new significance with the display technique—the "exhibition" began taking hold. One of the first and oldest of the true exhibitions began in Leipzig. Soon the Leipzig fair achieved an international reputation. Bomb damage destroyed many of the permanent buildings during World War II, but when the annual Leipzig trade fair resumed in 1947 it was as big as ever. A look at last month's Leipzig fair, in East Germany, and a comparison with the West German Hanover fair now in progress will be found on page 45.



And Mercedes Was Her Name

On the seventeenth of last month, there was a story conspicuously missing from many newspapers—the 125th birthday of Gottlieb Daimler. Although many are unsure whether it was Daimler of Karl Benz who invented the automobile, it cannot be denied that some of Daimler's engineering and styling concepts were breakthroughs in their day and may still be found in cars ambling along our highways today.

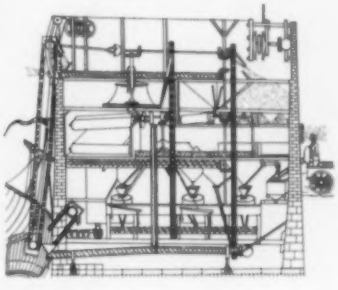
When Daimler was a young man, fresh out of engineering school, he joined and eventually became chief engineer of Gasmatorenfabrik Deutz, a company coowned by Nikolaus Otto, the pioneer of the four-stroke engine. It was fortunate that Daimler was able to work with Otto as theirs was a most symbiotic relationship. However, when two independent geniuses get together friction often results; so it was with Otto and Daimler. Internal problems became so unbearable that Daimler took a trip to Russia to allow tempers to cool down. Upon his return he found himself out of a job.

Daimler believed he could build a workable motor-driven car and, together with Wilhelm Maybach, a long-time friend and former engineer at the Deutz factory, he formed the Daimler Motorengesellschaft. Another German, Karl Benz, also was working on a motor car. In 1885, the year Daimler's car was patented, Benz built a ¾-hp one-cylinder petrol-driven vehicle. This strange contraption had four features still common to cars today: a water-cooled engine, mechanically operated inlet valve, electric ignition and a differential. The following year Daimler had his 1½-hp motor car on the market. Both companies were strong competitors until 1926 when they merged, forming the Daimler-Benz Co. Today the company manufactures trucks, buses and sedans, with an emphasis on sports and racing cars. The Mercedes body frame and front suspension are shown on page 57 as part of PRODUCT ENGINEERING's roundup of the '59 International Automobile Show.

There's nothing new about racing cars. As early as 1894, automobile racing was a serious and widespread sport in Europe. Backing for racing came primarily from financiers Baron Rothschild and Emile Jellinek. The latter was Consul for the Austro-Hungarian Government, as well as Daimler's distributor in Southern France. In 1900, shortly after Damlier's death, Maybach took control of the company and was approached by Jellinek with designs for a new racing car. Maybach told Jellinek that if someone would order 30 cars and pay in advance, production could commence immediately. Jellinek agreed to put up the money under one condition. He had a daughter whom he adored; Maybach could have the money if he named the car after her. Maybach thought this a small price and agreed on the spot. In its first 19 races, the Mercedes took either first place or first and second.

Oliver Evan's Automated Mill

Henry Ford was not the first American to establish an automated assembly line. For that honor you've got to go back to 1784 and the young engineer Oliver Evans. Realizing the problems of processing grain from kernel to flour, he designed and constructed the world's first fully automated factory—a mechanical mill. It was built in eastern Delaware and could be loaded from either a boat or a wagon. Grain was carried to the top of the mill by a bucket conveyor. Then leather belts carried it through the various milling operations. (These belts, also an American first, were the prototypes of conveyor belts discussed on p 51). Grain made its way through all floors very much the way auto bodies did in Ford's plant of 1914. The whole plant derived its power from an overshot waterwheel.



Although this amazing mill actually worked, it didn't impress the millers of the region. They reported that "the whole contrivance was a set of rattle traps unworthy the attention of men of common sense." Millers from other states took a look at the automatic mill and refused to invest money, claiming that if local millers wouldn't buy it, why should they?

Evans was able to obtain America's fourth patent after showing his mill to a specially formed committee. When the committee showed interest in the young engineer, he confided his plans to build a steam carriage. The committee reluctantly gave him a patent on the mill but said he was a lunatic and—for his own safety—advised him to keep quiet about his other fantastic ideas.

—Benedict A Leerburger Jr

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GET TOTAL MOTOR BURNOUT PROTECTION* AGAINST ALL POSSIBLE CONDITIONS THAT CAUSE OVERHEATING WITH KLIXON TYPE T PROTECTED MOTORS

Manufacturers of motor driven equipment can obtain induction motors that have *complete protection against all possible conditions that cause overheating and burnouts* simply by specifying on their motor purchase order — "These motors to have KLIXON Type T Protectors".

Built-in as an integral part by the motor manufacturer, the KLIXON Protector permits maximum overload performance with safety by safeguarding the motor against all abnormal operating conditions beyond the control of the manufacturer. These include: low voltage, blocked ventilation, high ambient temperature, stalling, excessive overload, improper current supply, jammed load, faulty belts or couplings, improper lubrication, electrical component failure, mechanical failure and improper installation.

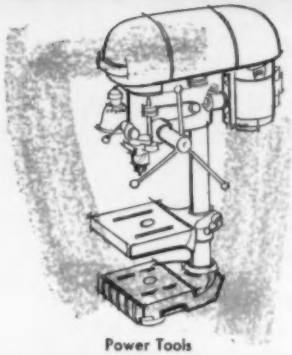
Here's what *complete protection* gives you — safe maximum motor output without premature motor failure, reduced motor repairs, replacements and service calls.

NO OTHER PROTECTOR PROVIDES 6-WAY COMPLETE PROTECTION

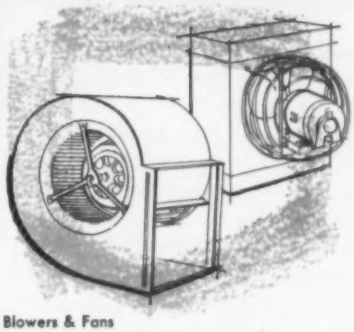
Most conventional protectors used today may protect motors against up to four overheat conditions. KLIXON Type T Protectors safeguard motors from *all* six conditions:

1. Running overload with or without high ambient or ventilation blocked.
2. Locked rotor normal voltage such as caused by mechanical failure of driven load.
3. Locked rotor caused by low voltage where decreased torque is insufficient to start load.
4. Locked rotor with main winding only in circuit resulting from open circuit start switch failure or open circuit in reversing switch.
5. Locked rotor with start winding only in circuit, such as that resulting from an open main winding circuit or open circuit in reversing switch.
6. Running with both start and main windings in the circuit resulting from start switch failure in closed position or low voltage which prevents reaching switch-over speed.

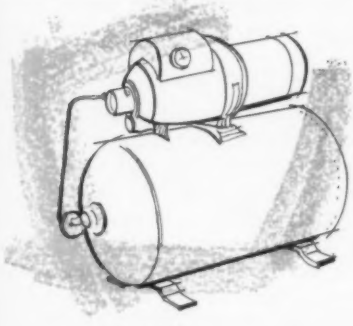
Oil Burners



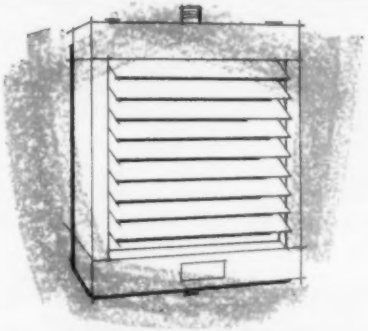
Power Tools



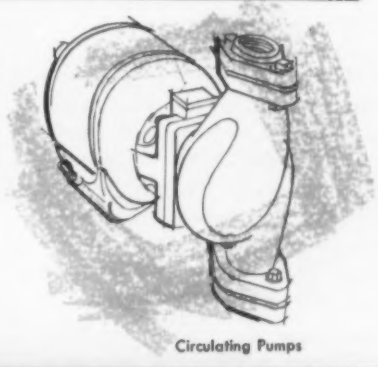
Blowers & Fans



Well Pumps



Heating and Cooling Equipment



Circulating Pumps

Over 150,000,000 motors are protected against overheating and burning out with KLIXON PROTECTORS

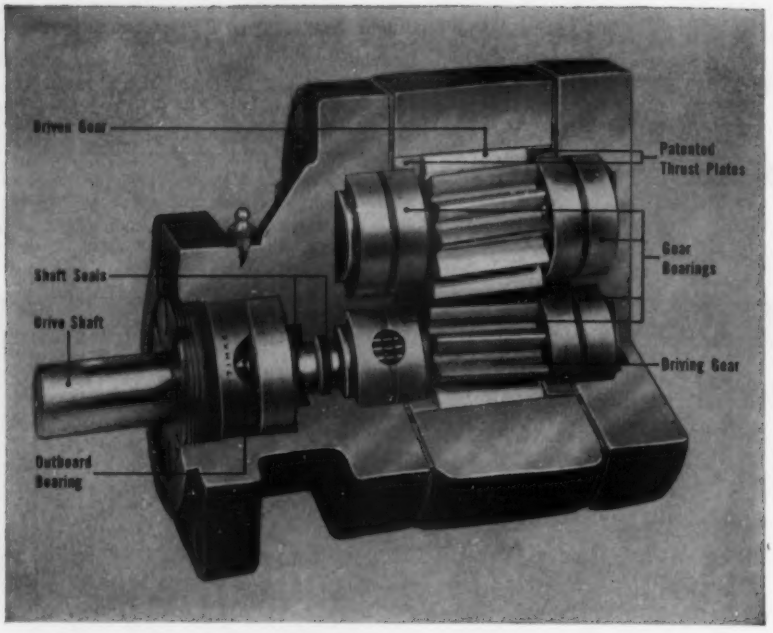
METALS & CONTROLS CORPORATION

Spencer Division

3804 Forest St., Attleboro, Mass.

KLIXON®

ADVANCES IN HYDRAULIC PUMP DESIGN



Oil leakage controlled

In any method of mounting an oil-hydraulic pump there is always a certain amount of misalignment between the pump drive shaft and the shaft on the power source. Even where universal drives are utilized there is still the danger of a thrust load. Result in both cases: Flexing is transmitted into the pump seal and eventually to the bearings supporting the gear—leakage around the shaft is a sure-fire bet to follow.

At Commercial, by using an outboard bearing to protect the seals and internal bearings, the common leakage nuisance is eliminated.

Internal alignment perfected

Mass production of independent gear pump housing parts invariably results in varying degrees of internal misalignment—regardless of dowel pin control points used in machining. In many cases the "out" for the problem involves a loosening up on the internal tolerances—with a resultant loss in efficiency.

At Commercial, the patented thrust plate serves as a "natural" alignment control point—is counter bored on its face to match the bearing sleeve, then fits over the bearing sleeve and in turn pilots inside the gear housing. Perfect internal alignment—and increased efficiency—in any Commercial oil-hydraulic pump is axiomatic with rigid inspection of the thrust plate alone.

Constant volume assured

The principle of automatic adjustment of end clearance by internal pump pressure had one main weakness. The full pump pressure was applied against the whole area of each thrust plate. The plates would wear unevenly because on the inlet side of the pump the plate had full pump pressure on one face and a vacuum on the gear side.

By "pressure pocketing" Commercial insured that the pressures on opposite faces of the thrust plates would be in approximate balance around the entire area of the plate faces. Commercial's "one-two" advance design punch—the patented "pressure pocketed" thrust plate—assures constant volume at any pressure and at the same time helps to maintain simplicity of design and soundness of construction . . . provides for longer operating life and no maintenance headaches.

Seizing eliminated

Commercial oil-hydraulic pumps cannot seize because of heat induced by high speed or even inadequately piped systems. Variable end clearance and positive internal alignment make seizing practically impossible. Bearings evenly loaded throughout their length—no corner loading or spawling—are able to withstand much higher operating pressures. They stay in service longer too—regardless of pressures involved.

To take full advantage of tight internal tolerances Commercial designs, produces and grinds its own rotating gears—is able to hold extra close tolerances on tooth contours, outside diameters, and concentricity.

Over 5,000 different pump combinations—port locations and sizes—can be built from Commercial's standard line of oil-hydraulic pump components. A wide variety of drive shafts and mounting combinations are available to solve virtually any individual installation, piping and power application requirement.

Engineering help available

Commercial's oil-hydraulic pump engineering advances are typical of its complete line of oil-hydraulic equipment. The solid technical help Commercial sales engineers can contribute on the application of oil-hydraulic pumps, motors, cylinders and valves may be able to help cut your costs and improve performance.

ENGINEERING DATA FREE

For more information write to Dept. G-18 Commercial Shearing and Stamping Company, Youngstown 1, Ohio. Better yet, send for your copies of Commercial's free engineering reference bulletins. Just check the items below in which you are interested.

- ☐ "Oil-Hydraulic Pumps and Motors Catalog H-4"
- ☐ "Performance Rated Oil-Hydraulic Valves Catalog H-12"
- ☐ "Oil-Hydraulic Cylinders Catalog H-3"

COMMERCIAL
shearing and stamping

Fewer replacements, farther between

...with these LINK-BELT conveyor and elevator chains

LINK-BELT C CLASS CHAIN combines cast malleable center links with steel sidebars connected by steel pins. Broad tops and bottoms provide ample sliding surfaces for drag conveyors. Also available with Promal or "file-hard" Promal center links for extreme loads and abrasive wear. Promal is the special Link-Belt metal that lasts much longer . . . costs but little more.

LINK-BELT SS CLASS BUSHED CHAIN. If your conveyor or elevator must be lengthened, or load increase accommodated, you can install this all-steel chain in place of C Class *without changing sprockets!* It offers hardened joint bearing surfaces for greater wear resistance in heavy-duty conveying and elevating. Smooth, tough joint surfaces repel gritty materials, prevent packing, and resist abrasion.

Full information on these chains . . . plus a broad line of attachments — is contained in Catalog 1050. Get your copy by writing direct . . . or call your nearest Link-Belt office, listed under CHAINS in the yellow pages of your local Phone Directory.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,060

DOW | **NEW PLASTICS** *inspire new product designs*

The news columns have been filled recently with rapid-fire developments in thermoplastic materials . . . materials that hold promise for the improvement of hundreds of products, both old and new. As these stories break, you'll notice a high percentage of them featuring a Dow material. Take Zerlon* 150. A few weeks ago Dow introduced this weather resistant, optically clear plastic with an exciting new range of cost-saving properties. Several other news-makers in the complete Dow line are discussed on these pages.

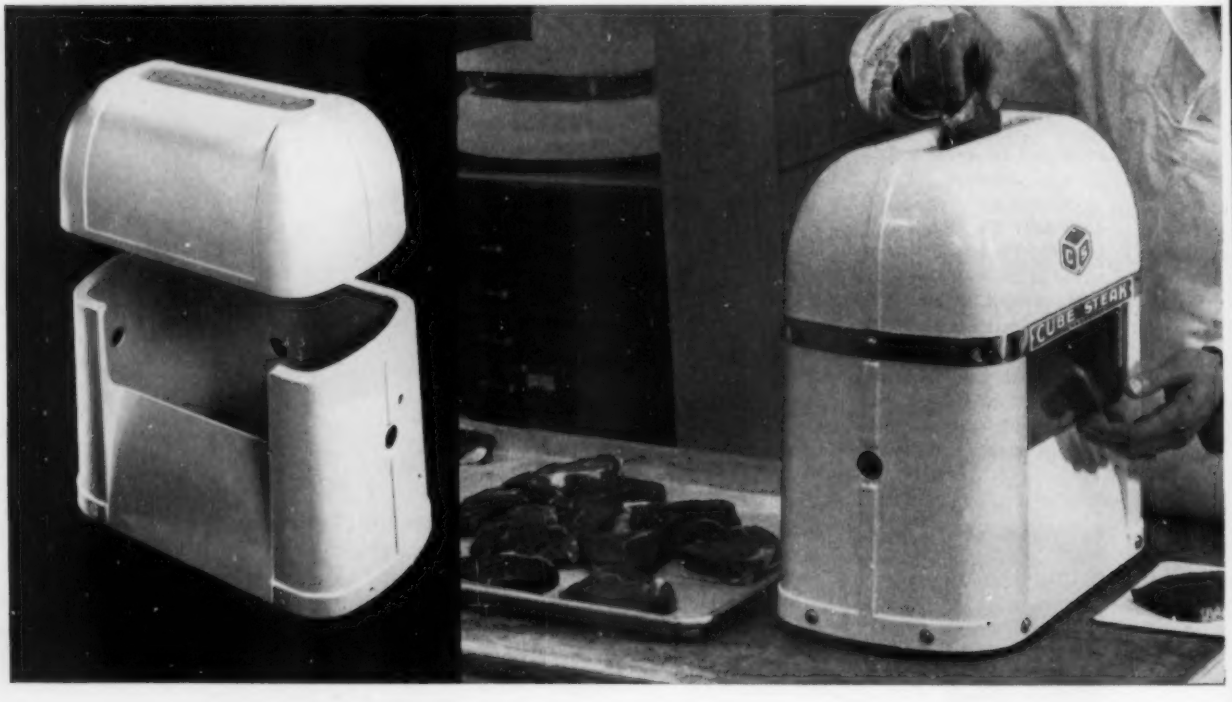
*Trademark

"AGELESS" STYRON 480 GIVEN LIFETIME GUARANTEE IN NEW SUPERMARKET TOOL

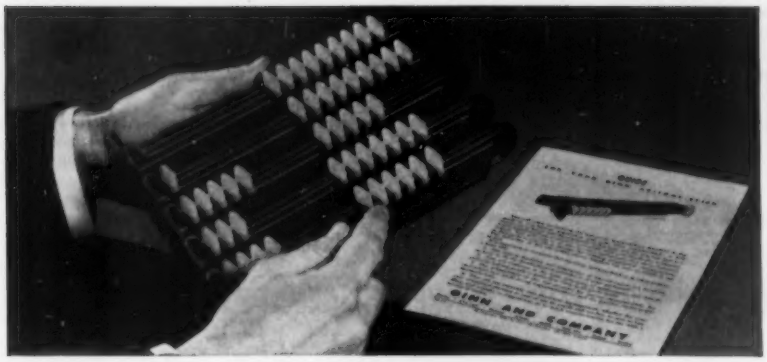
The housing of this new Cube Steak Tenderator is guaranteed for the life of the machine. This is a generous guarantee to make on equipment in rough and tumble supermarket service, but the manufacturer isn't worried . . . he knows the housing is made of Styron® 480. This versatile thermoplastic was chosen because it's durable and highly resistant to meat juices, has super high impact strength, an easy-to-clean surface.

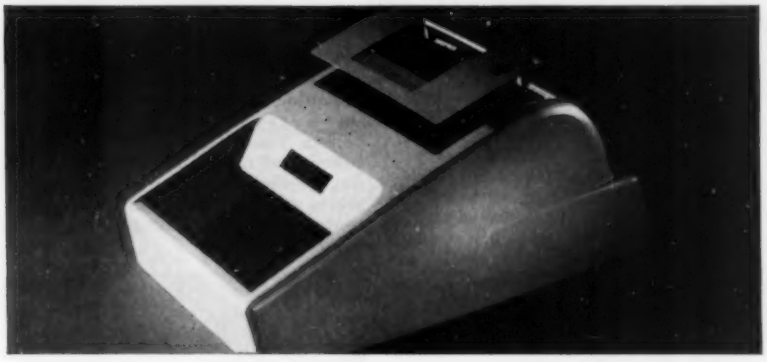
The excellent aging characteristics of Styron 480 were also an important consideration. In fact, the lifetime guarantee could not have been made without them. Fabrication was simplified and production costs substantially reduced by switching to plastic.

The housing made of Styron 480 is an excellent example of how Dow plastics help make good products better. An increasing number of manufacturers are selecting from the extensive Dow line of eight basic thermoplastics and dozens of specialized formulations. And you get extras from Dow you can't buy on a cost-per-pound basis: technical service, marketing assistance and a color styling service that's second to none.



THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN





Ready for the sales countdown . . .

with this abacus made of Styron 475

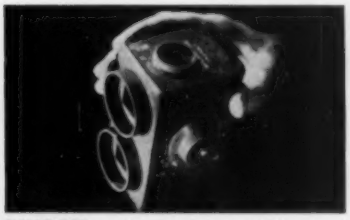
A prominent publishing house markets this attractive, highly useful educational tool. It's made of polyethylene and Styron 475, a high impact Dow plastic with excellent dimensional stability, design flexibility and moldability to spare. This abacus was developed for the publisher by a custom molder who offers integrated design, engineering and production services. It's another example of how creative engineering utilizes the many benefits of Dow plastics in new product designs.

. . . and this adding machine housing molded of Styron 440

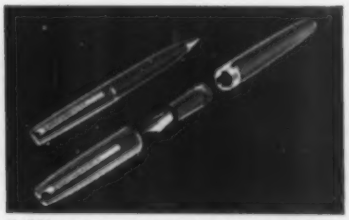
Outstanding impact strength, design versatility and a wide range of colors make Styron 440 an obvious choice for this application. The housing is easy to keep clean and its high resistance to heat prevents distortion when the machine is displayed in direct sunlight. Styron 440 also eliminated the extra fabrication and finishing operations that were necessary with the material previously used in the housing. The surface is smooth and polished when removed from the mold.

4 MORE PRODUCTS

fashioned from America's first family of thermoplastics



ETHOCEL. "The aristocrat of plastics," Ethocel® provides exceptionally high impact strength for this compact transit. Its superior dimensional stability helps keep the lens positioned in the one right place.



TYRIL. Characteristics such as beauty, strength and resistance to perspiration make Tyril® the ideal choice for this pen and pencil set. Tyril also provides excellent moldability for intricate details such as threaded sections.

STYRON 440. This new speaker housing for auditorium walls utilizes many of the properties of versatile Styron 440: Excellent large-area molding characteristics, a surface that requires no finishing.

TYRIL. This transistor radio housing made of Tyril has toughness, dimensional stability and a wide range of colors. Excellent electrical properties are other benefits of this outstanding Dow thermoplastic.

FOR MORE INFORMATION about the versatile Dow plastics and the product designs discussed on these two pages, write to us today. THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department 1510DZ4-27.

Industrial Molding Materials • Packaging Materials • Paint and Coating Materials • Building Products

DOW

DESIGNING WITH ALUMINUM

NO. 30

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11, Illinois.

ALUMINUM IN LOW TEMPERATURE APPLICATIONS

THE STRUCTURAL QUALITIES of aluminum and its alloys are actually improved at ultra-low levels of temperature, such as are encountered in the manufacture and handling of liquid gases. Tensile and yield strengths rise markedly, and percentage of elongation increases. As the lowest-cost metal capable of performing satisfactorily at temperatures below −150°F., aluminum is thus valuable to the rapidly expanding field of cryogenic applications.

Aluminum alloys also are unique among commercial metals in their combination of high strength-weight ratio, corrosion resistance, formability, weldability, reflectivity, and conductivity of heat and electrical energy. Also important for purposes of handling volatile liquids, aluminum is non-sparking, nonmagnetic and non-toxic.

The requirements of commercial gas applications are filled chiefly by four industrial gases (see Figure 1). Oxygen, nitrogen, argon and helium—in that order of volume—comprise much the greater portion of commercial gas manufacture. Oxygen, nitrogen and argon are among the gases that are produced by liquefying air at −320°F. to effect a separation of each gas at its individual boiling point as a liquid. Equipment for this production can use, and has used, large quantities of aluminum alloy sheet, plate, extrusions, tubing and pipe.

These gas products, along with natural gas (mostly methane) are reduced by cooling and liquefaction to volumes only about 1/600 to 1/800 of their gaseous volume. *And because consumption by industry in both old and new applications currently amounts to hundreds of millions of cubic feet annually,* this reduction in handling bulk is of immense economic importance.

One of the latest military missiles, for example, consumes 420 cubic feet of liquid oxygen . . . 336 thousand cubic feet as gas . . . in a 90-second firing period. These liquefied gases may be stored and moved in aluminum alloy double-shelled insulated tanks, thus taking advantage of their extreme concentration in the low-temperature liquid state.

Double-shelled mobile liquid-oxygen tank, produced with Kaiser Aluminum alloy 5086. Used in fueling missiles, this tank is being loaded for transport by air.

FIGURE 1

SOME PROPERTIES OF COMMERCIAL GASES

	BOILING POINT OF LIQUID GAS (Fahrenheit)	LIQUID DENSITY AT BOILING POINT (Lbs./cu.ft.)	GAS DENSITY * (Lbs./cu.ft.)	APPROX. VOLUME INCREASE, LIQUID TO GAS *
OXYGEN	−297	71.2	0.089	799
NITROGEN	−321	50.4	0.078	650
ARGON	−302	88.02	0.1114	770
HELIUM	−452	7.82	0.0111	700
NATURAL GAS (Chiefly Methane)	−265	25.9	0.0447	580

* Gas at normal temperature and pressure.

FIGURE 2

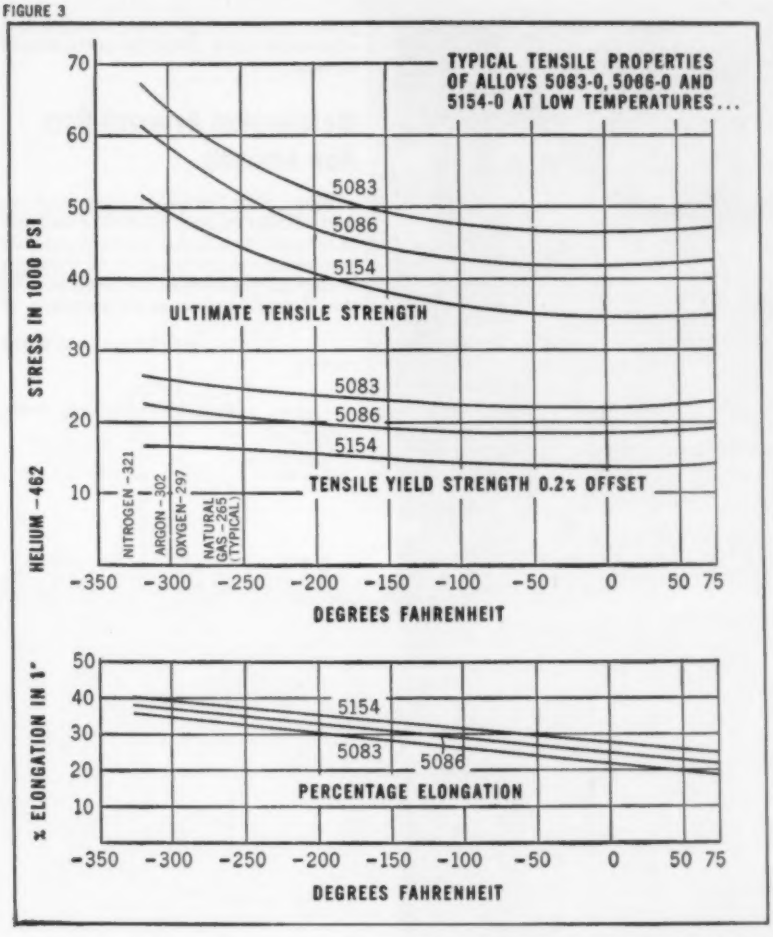
TYPICAL TENSILE PROPERTIES OF SOME ANNEALED ALUMINUM ALLOYS APPROVED BY ASME FOR UNFIRED PRESSURE VESSELS

ALLOY DESIGNATION AA	ALLOY DESIGNATION ASTM	ASME SECTION OR CASE NO.	TENSILE STRENGTH (psi) Ultimate	TENSILE STRENGTH (psi) Yield	ASME ALLOWABLE DESIGN STRESS * VALUES (psi)	MINIMUM REQ'D WELDED TENSILE STRENGTH (psi)	PERCENT ** ELONGATION
1100	990A	8	13,000	5,000	2,350	11,000	35
3003	M1A	8	16,000	6,000	3,150	14,000	30
3004	MG11A	8	26,000	10,000	5,650	23,000	20
5050	G1A	8	21,000	8,000	4,000	18,000	24
5052	GR20A	8	28,000	13,000	6,250	25,000	25
5154	GR40A	1174	35,000	15,000	7,350	30,000	27
5086	GM40A	1222	38,000	17,000	8,700	35,000	22
5083	GM41A	1247	42,000	21,000	10,000	40,000	22

* For metal temperature not exceeding 150°F.
** In 2 inch flat 1/16" gauge specimen at 75°F.

Nominal chemical compositions:
5154—Magnesium 3.5%, Manganese 0.05%, Chromium 0.25%
5086—Magnesium 4.0%, Manganese 0.45%, Chromium 0.15%
5083—Magnesium 4.45%, Manganese 0.75%, Chromium 0.15%

FIGURE 3



Several weldable aluminum alloys have been approved by the American Society of Mechanical Engineers as safe and suitable for construction of unfired pressure vessels such as are used in the handling of liquid gases.

Figure 2 tabulates typical tensile properties and the design stresses permitted by the ASME Code for some of these alloys, including high strength aluminum-magnesium compositions. All values shown are for metals in the annealed state. Kaiser Aluminum alloys 5083 and 5086 are the strongest ASME-approved aluminum-magnesium-manganese alloys that can be fabricated into these welded vessels by all normal methods, without need for stress-relieving or annealing. Both of these Kaiser alloys 5086 and 5083, when welded with 5183 filler, also meet the stringent "2T" bend test requirements for welds established by ASME for most other materials in these unfired pressure vessel applications.

The allowable design stress values shown are specified by ASME as acceptable for vessels and appurtenances from 150°F. down to –325°F. These permissible values are roughly two-thirds of the minimum guaranteed yield strength of the alloy at room temperature. Since the ultimate tensile and yield strengths of aluminum alloys increase as temperatures drop, the margin of safety rises still further at liquid gas temperature levels.

The low temperature behavior of alloys 5154, 5086 and 5083 is exemplified approximately in Figure 3. Ultimate strengths increase by about 50% from room temperature to –320°F. Yield strengths rise by about 18%. Thus, at the –320°F. level, the yield strengths of these three high-strength alloys approximate 2¼ times the stresses allowed for pressure vessel design by the ASME Code.

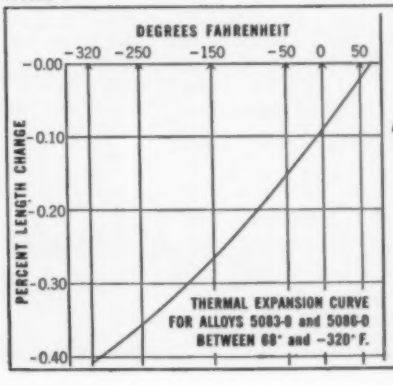
Through the same temperature range, percentage elongation properties have been shown by test to increase 60% or more, reaching the magnitude of 40% elongation at –320°F.

This added strength and ductility contribute much to structural dependability against both mechanical shock and large temperature differentials in different portions of the same aluminum part or system.

The thermal contractions encountered in ultra-low temperature equipment are larger than those to be accommodated in ordinary design applications. For example, an aluminum member 25 feet long contracts by about 1¼-inch through the range from 68° to –325°F. Figure 4 shows these thermal expansion characteristics, as typified by aluminum alloys 5086 and 5083.

The low elastic modulus of aluminum also contributes to its suitability for low-temperature equipment by mitigating the adverse effects of thermal contraction. Thermal deformations cause much smaller increases or decreases of stress in aluminum parts than in equivalent stainless steel parts. The representative #304 stainless steel listed in Table 4 will contract only about 70% as much as the high strength weldable aluminum alloys, for any given drop in temperature. However, the aluminum alloys have an elastic modulus of about 10,300,000 psi, roughly one-third that of the steel. Because of this difference in elastic moduli, the stress changes resulting from thermal deformation through any given temperature change

FIGURE 4



THERMAL EXPANSION COEFFICIENTS OF ALUMINUM ALLOYS AT LOW TEMPERATURES

Average Coefficients of Thermal Expansion (x 10^{-6} per degree F.)

ALUMINUM ALLOYS	68° to –200° F.	68° to –320° F.
1099	11.8	10.5
3003	11.2	10.0
5083	11.6	10.4
5086	11.6	10.4
6061	11.3	10.2
#304 Steel (Stainless)	7.7	7.4

CONTINUED ON NEXT PAGE ➡

Assembly of welded aluminum vessel for a liquid-oxygen generating plant. Such plants serve the steel and chemicals industries.

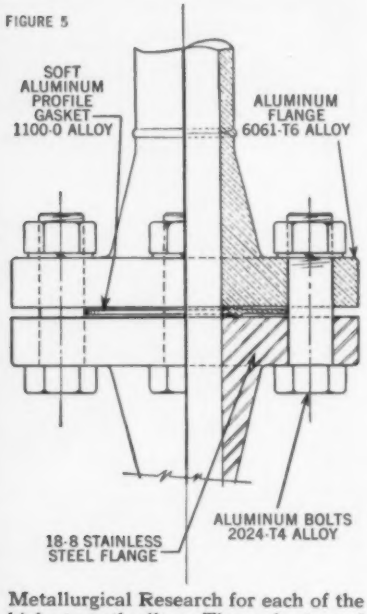
will be lower in the aluminum than in the steel.

One example of the advantages offered by this capacity for large elastic thermal deformations is the ability of aluminum alloy flanged joints, using 2024-T4 aluminum bolts, to maintain joint tightness under cyclical temperature conditions between 250°F. and –320°F. A bolt-loosening effect naturally occurs during the initial contraction of the pipe bore as it is cooled to liquid-gas temperatures, while the outer flange and the bolts remain relatively uncontracted at ambient levels. This tends to reduce gasket seating pressures. However, the loss of stress in aluminum bolts and flanges during thermal contraction of the pipe is much less than that occurring in equivalent steel parts. This ability to maintain stress during thermal deformations, along with the use of a soft aluminum profile gasket next to the bore, maintains adequate sealing while the flanges and bolts also cool. Since it often is desirable to bolt an aluminum flanged line to a stainless steel flanged line, for heat-dam purposes, this elastic property dictates that aluminum alloy 2024-T4 bolts should be used.

Metallurgical Research Data Now Available

Since most liquid-gas containers require a high vacuum between outer and inner shell to achieve the best possible insulating conditions, external pressure design charts have been developed by the Kaiser Aluminum Department of

FIGURE 5


SOFT ALUMINUM PROFILE GASKET 1100-0 ALLOY
ALUMINUM FLANGE 6061-T6 ALLOY
ALUMINUM BOLTS 2024-T4 ALLOY
18-8 STAINLESS STEEL FLANGE

Metallurgical Research for each of the high strength alloys. These charts, and other information on aluminum use in low temperature applications, are available to interested manufacturers.

For immediate attention to your request for these charts and other technical information—or for engineering assistance in your own applications—contact the Kaiser Aluminum sales office listed in your telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

see our catalog in PRODUCT DESIGN FILE or write for copy

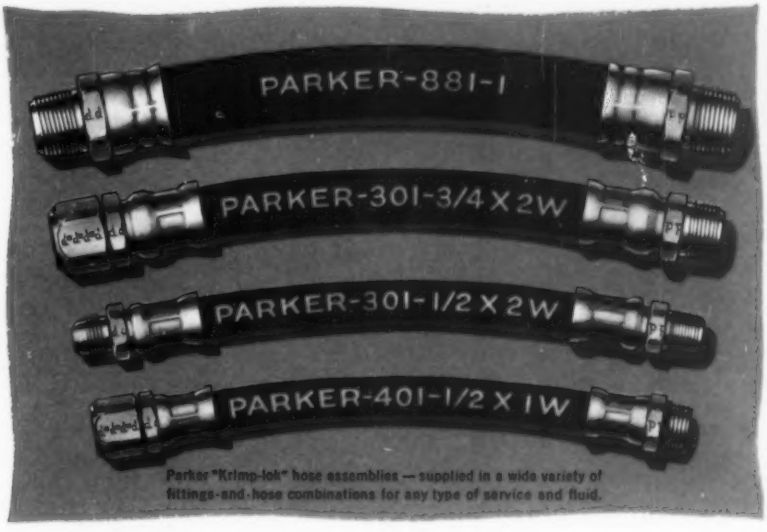
KAISER ALUMINUM

THE BRIGHT STAR OF METALS

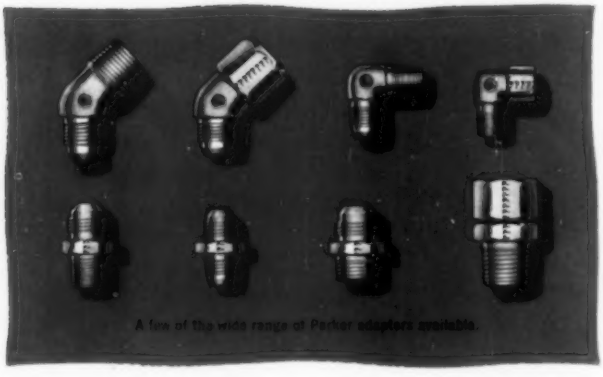
PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS

Now from Parker

BOTH permanent-end and re-usable hose assemblies



Parker "Krimp-lok" hose assemblies — supplied in a wide variety of fittings-and-hose combinations for any type of service and fluid.


A few of the wide range of Parker adapters available.

You may require permanent-end hose assemblies for your production AND re-usable fittings with coils of hose for quick, trouble-proof replacements in the field. With the addition of Parker's new "Krimp-lok" fittings, permanent-end assemblies are now available from Parker. They use the same Parker hoses that enjoy a wide acceptance when used with Parker *no-skive* "Hoze-lok" fittings in the replacement field.

A full range of Parker adapters is also available.

Ask your Parker Hose Distributor, listed in the Yellow Pages, for engineering advice and literature on "Hoze-lok" re-usable fittings, also Parker hose and adapters. Write us in Cleveland regarding your requirements for Parker "Krimp-lok" Hose Assemblies.

Parker

FITTINGS AND HOSE DIVISION

17325 Euclid Avenue

Cleveland 12, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION

From HANNIFIN...

unit construction

to give you air valves

that do more jobs

Hannifin ¼" four-way valve with "universal" base and new Speed Control section. Single-solenoid actuated, 10 other actuators available.

Hannifin's exclusive "spool-poppet" seals bubble-tight at either end of its short stroke.

For complete J.I.C. compliance, valve is electrically inoperative until dust-tight, splashproof solenoid cover is replaced and fastened tightly. Result: no more clogged, jammed solenoids.

One of the versatile—and most popular—Hannifin air control valves is this "CC" series, single-solenoid model. It is available for either ¼" or ⅜" air lines and is gasket-mounted to its own base. This particular base (one of three choices offered) can either be O-ring gasketed to your manifold or mounted over an opening in your bracket or machine. It will receive all four lines from below or take the inlet line from below and the two cylinder lines out one side. Or, you can make all connections at the sides.

When it comes to actuation, Hannifin offers an even wider selection: hand, foot, cam, pressure, single or double solenoid.

When necessary, you can remove this entire valve from its base without disconnecting air lines. Or, the exclusive "spool-poppet" can be replaced without even breaking electrical connections.

The "CC" series, like all Hannifin valves, is designed with "full flow" internal passages as large or larger than its rated pipe size.

You will find these and most other Hannifin valves described in Hannifin's new "Valve Finder." Get your copy from your Hannifin man, listed in the A-Z volume of Thomas' Register, or write:

HANNIFIN COMPANY

525 South Wolf Road • Des Plaines, Illinois

DEVELOPMENTS TO WATCH...

Foamed plastic "smoke"—clouds of foamed particles . . .

. . . that may serve as reflectors for radio waves or tracers for outer space rockets, as well as for more-conventional signaling and camouflage uses, is being developed by the Radiation Lab of Johns Hopkins U under WADC contract.

The original Air Force aim was to find a smoke which would have "a settling rate slower than that of any existing smoke particles, be relatively harmless to personnel and equipment, and readily colored for signaling purposes." (Previously available smoke-producing materials all had specific gravities of one or more; and, though smoke particles were less than 1 micron in dia., the average smoke density was about 2 gm/cc.)

To bring the density down and the particle size up, JH researchers tried all sorts of materials—and finally came up with foam-in-place plastics—particularly phenolics and urethanes—as the most promising possibilities.

A gas turbine fire pump has been pressed into service as a mixer and atomizer, with the resin and catalyst being fed into the gun simultaneously. Even with this rudimentary equipment, Betty Lou Raskin of the Radiation Lab told a recent American Chemical Society meeting, foams with particles up to 10 microns in dia and densities down to 0.0012 gm/cc, equal to or less than that of air, can be produced.

Efforts now are being directed toward improved equipment design and such refinements as metallized particles; and new application possibilities are being explored.

Dry-film lubricants that won't rub off . . .

. . . are being sought by the Navy, and recent reports indicate considerable progress has been made. Furthermore, materials now under test seem stable at temperatures from −350 to 750 F, show good resistance to radiation, and are effective even when bearings are immersed in liquid oxygen. Key to their success: substitution of inorganic binders for the organic materials now most commonly used.

As E. R. Lawson and M. J. Devine of the Naval Air Material Center pointed out to a recent Navy Science Symposium sponsored by the Office of Naval Research, organic binders in general are not sufficiently hard to resist the continual rubbing action of the balls, and failure occurs where the binder rubs off. Furthermore, the service life of such binders is very short even at temperatures of 350 F.

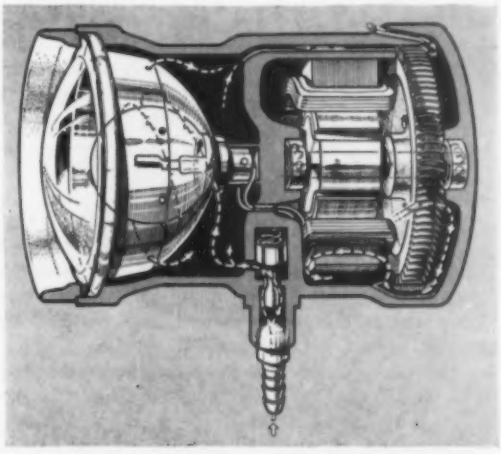
In the search for a harder, more wear-resistant binder, Navy researchers turned first to the soluble sodium silicates, and good results have been achieved, using about 39 parts of sodium silicate with 55 parts of molybdenum disulfide and 6 parts graphite. Now a number of other lubricants and binders are under test; among them: boron nitride, lead iodide, lead oxide, titanium sulfide and tungsten sulfide (as lubricants); and sodium phosphate, and potassium borate, and silicate (as binders).

An air-operated safety light . . .

. . . that's flameproof, explosionproof, portable, and requires no outside electrical source, has been developed in Sweden and is now under test here.

Atlas Copco AB, Stockholm, the manufacturer, says it will operate at any air pressure from 60 to 100 psi, has a special reducing valve in the inlet (see diagram) that keeps the turbo-generator operating at constant speed regardless of pressure variations in the primary air supply. The fact that entering air goes through the pressurized reflector chamber on its way to the turbine is an added safety feature: If the lens breaks, pressure is lost, and the turbine immediately stops.

When tests are completed, Atlas plans to market this 12-v, 150-w, air- and gas-tight, 22-16 unit in this country.



In safety lamp, entering air flows past a reducing valve and through the pressurized reflector chamber on its way to the turbine (right). Exhaust air from the turbine is also fed forward to keep the lamp cool.

←Circle 108 for Fittings, 109 for Valves

DEVELOPMENTS TO WATCH...

Dissimilar elastomers can be bonded before curing . . .

. . . with a new adhesive now available for engineering evaluation. According to its developer, Lord Mfg Co, it will bond unvulcanized butyl to neoprene, natural, or nitrile rubbers and accomplish many other "impossible" combinations. It may also be used as a primer in bonding rubber to metals and plastics. Suggested applications include bonding wire and cable jackets to insulation, and the production of composite rolls.

Samples of the adhesive, EX-B150-1, are now available, on letterhead request, from Dept 88, Special Products Div, Lord Mfg Co, Erie, Penna.

An O-ring that won't pop out . . .

. . . has been developed by Chance Vought engineers. They claim the new design, which features a built-in concentric spring, should eliminate need for anti-extrusion devices at high temperatures.

They say it can be used in hydraulic and pneumatic systems at temperatures to the 400-F range.

Research is continuing, under Wright Air Development Center contract, with the ultimate goal a ring that will stand temperatures from at least −65/to 600 F and pressures from 0 to 4000 psi, and will be compatible with high-temperature hydraulic fluids and resistant to hot gases.

Faster drying coatings with improved hardness . . .

. . . reduced water-vapor permeability, and greater resistance to aromatic solvents can be made by combining castor polyols and isocyanates, say researchers from Baker Castor Oil Co. In reports to the American Chemical Society, they note that urethane coatings prepared with castor-oil derivatives promise to outperform alkyds, particularly over the long term; and can be produced at a cost comparable to, if not lower than, other types of urethanes.

Urethane coatings prepared with a variety of polyether polyols are also under study at Wyandotte Chemicals; and the company says they have excellent abrasion, solvent, and chemical resistance, combined with toughness, a wide range of flexibility, and good adhesion to many substrates. Wyandotte researchers believe, "the versatility of properties exhibited by these coatings appears to make them suitable for application in pigmented or unpigmented form on wood, concrete, leather, paper, rubber, and other substrates."

New lubricants and fluids for activating mechanisms . . .

. . . may result from US Dept of Agriculture research on a new type of starch derivative, a cross-linked dicarboxylate starch, that forms a paste when heated in water, yet does not jell when cooled. Furthermore, the cooked pastes have unusual clarity (81-99% light transmission as compared to about 64% for ordinary starch); are stable in storage.

Data sheets and R&D samples are obtainable from the USDA Northern Utilization Research & Development Div, Peoria, Ill.

Doubts about transistors . . .

. . . are being voiced in a number of quarters. Not that these mighty mites are not extremely valuable components. But too much attention has perhaps been paid to the advantages of transistors and not enough to their limitations.

The plain, unadorned transistor, for instance, is a lot smaller than any tube capable of doing the same job. It requires less power for operation. But in some cases it may take 10 transistors to do the job accomplished by a single tube; and it may take enough auxiliary equipment to fit those transistors into the circuit to more than make up for any size differential. Too, it is now generally recognized that, while the heat resistance and frequency capability of transistors is being improved (PE—Oct 28 '57, p 52), they still leave much to be desired.

Furthermore, tube design has not been standing still while transistors have been developing. Some of the newer tubes promise even to beat transistors at their own game—simplicity of manufacture and space saving (PE—Apr 6, p 9).

Result: a good many organizations are considering more equipment of mixed design.

Transistors are here to stay. But they're going to have to earn the right to be considered for each specific job. —ARG

Largest Static Control System Described at Machine Tool Forum

BUFFALO—A description of the world's largest static-control system created from a new static-oriented design highlighted the 2-day Westinghouse Machine-tool Forum conducted for more than 450 manufacturers and users of machine tools and electrical components.

The outsized static control is installed at Ford Motor Co's automatic-transmission plant in Sharonville, Ohio. Over 6700 static "Cypak" modules (Westinghouse) help control a production rate of about one transmission every 20 seconds. The engineers who created the system experimented with three design techniques: (1) methodical replacement of conventional relays in known circuits; (2) trial-and-error; and (3) new static-oriented design. They reported at the meeting that the third method worked best and required surprisingly little advanced switching algebra.

Also reported was the first automated wheel-and-axle shop for railroad maintenance, designed by Farrel-Birmingham Co, Inc. They claim 10:1 reduction in man-hours per repair. This installation used conventional electromagnetic and electrohydraulic controls; static controls would also be considered for future designs.

Major sources of electrical trouble are limit switches and power devices such as relays and solenoids, in the opinion of many attending the forum. Less troublesome are intermediate logic elements, whether static or conventional—explained by the fact that they are away from the machine and see less-severe duty. In general, static elements were thought more reliable by most users, but several controversial points were raised. First, static elements such as magamps and transistors cannot be applied at critical points as readily as limit switches or power relays, thus avoiding a true test of reliability; and ordinary relays give perfectly dependable service if used in logic circuits.

On exhibit were several other recently developed electrical components. One, an amplifier using a Westinghouse Trinistor "solid-state thyratron", had a gain reported to be 10^6. The whole amplifier occupied less than 60 cu in., yet operated a conventional breaker rated at 100 amp and 440 volts. Another exhibit was a novel, reduced-size dc motor that was totally enclosed and fan-cooled. Fan blades in this design had notches that meshed with notches in the outside surface of the heat-exchanger wall. The outside air, drawn in by fan, traveled a circuitous spiral route that carried away a reported eight times as much heat as with previous smooth-walled design. New type silicone insulation, baked at 200 C, eliminated troubles from outguessing found in previous totally enclosed silicon designs.

Safety-type motor-starter enclosures were described by several companies. Westinghouse, for example, exhibited a NEMA type 12 enclosure that takes two hands to perform each of two critical operations: open the cover, and energize the switch if the cover is off. The cover is only ⅓ the height of the box; the handle, above cover, is in front and always engaged.

Announced in technical papers were several significant developments in control systems for machine tools. Telephone switchboard components were reported used exclusively in electric control for new Fosdick numerically controlled jig borer. Machine, called "Fosmatic" has another interesting feature that is not quite so new: table positioning is done entirely automatically with high-precision gage blocks that are stacked for each cut by complex gear and cam arrangement controlled by punched tape. Positioning accuracy claimed is 0.0001 in.

An old standby, the variable autotransformer, controls speed of dc shunt motor on a precision lathe. This simple control, designed by Barber-Colman Co, uses silicon rectifier and saturable reactor in addition to transformer. Also introduced at forum was Westinghouse "Reactifier." It has a magamp-controlled saturable reactor with silicon rectifiers to vary speed of dc motor. System is claimed to have superior performance in most respects but cannot have regenerative braking because of rectifiers in circuit.

A new calculating service to motor users, announced at forum, is available at Westinghouse plant in Buffalo. Digital computers there have programs that will accept input specifications from the customer, and give optimum motor design needed to meet specs. However, developing a program for the computer does not pay unless there will be large-quantity production; motor load cycles for special jobs will still need engineers with slide rules.

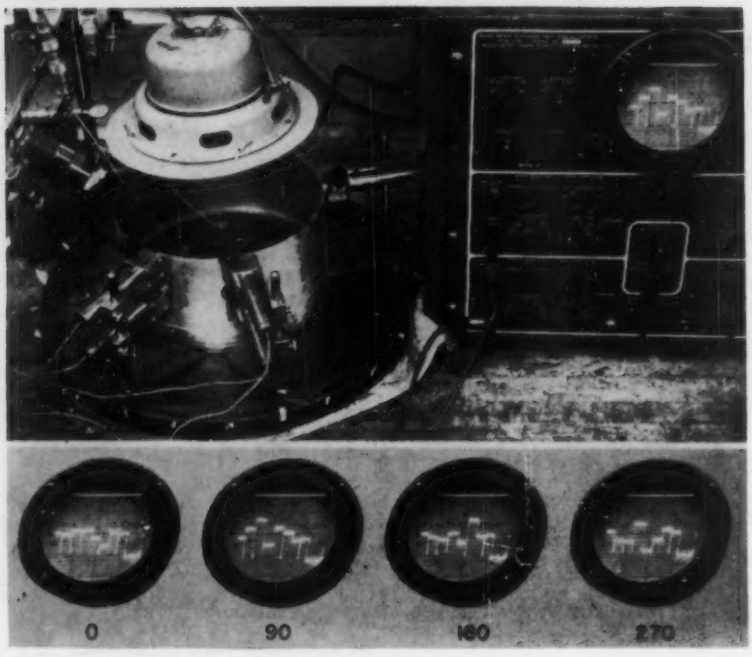
Foreign competition was much discussed. The kick-off speaker, Ludlow King, executive vp of NMTBA, called for more government protection from foreign competition. Luncheon speaker R. J. Kraut, president of Giddings & Lewis Machine Tool Co, stated that we are pricing ourselves out of the world market and will soon lose our lead as the foremost manufacturing country. G. W. Jernstedt, Westinghouse manager of manufacturing planning encouraged invited machine-tool manufacturers to develop machines that will improve not just technique, but basic methods of production. —Frank D. Yeaple

Engineering degrees are on the upswing . . .

but perhaps not for long. The US Office of Education has just announced that 35,322 men and women earned bachelors degrees during 1957-58. That's a 13.1% gain over the 31,211 earned in 1956-57. Engineering degrees will probably continue to increase for the next few years on the basis of freshman enrollments in the past few years. But a drop is likely in the early 1960's as a result of sharply decreased enrollments last fall. The US Office of Education also noted that advance engineering degrees are presently on the rise. Masters degrees awarded 1957-58 totaled 5788 compared with 5233 a year earlier. Doctorates totaled 647 compared with 596 the previous year.

YEARS	THOUSANDS OF DEGREES	
1949-50	52	
1950-51	42	
1951-52	30	
1952-53	24	
1953-54	22	
1954-55	23	
1955-56	26	
1956-57	31	
1957-58	35	
1958-59	36	(projected)
1959-60	38	"
1960-61	39	"
1961-62	34	"

NBS Develops Vibration Analyzer



Determines vibration characteristics . . .
Bell-shaped object above is the loudspeaker which vibrates cylinder below it. Horizontal traces, seen on the displays, can show relative amplitude of signals from the pick-ups mounted next to the cylinder wall. Changes in phase of beat frequency are noted along the bottom row.

WASHINGTON—A vibration analyzer which utilizes the principle of a stroboscope to determine vibration characteristics of bodies such as aircraft and missile structures has been developed by the National Bureau of Standards.

Specifically, the analyzer was developed for use in calibrating vibration pick-ups where vibrations other than longitudinal were unwanted. Transverse or flexural vibrations were eliminated by using several small pick-ups on various parts of the shaker.

In the analyzer, the motions of a body are first converted to electrical impulses by the pick-ups, and the resulting signals are sent to a mixer which adds a reference signal slightly lower than the frequency at which the body is vibrated.

Next, the difference signals are separated by a low-pass filter, or a square law detector. When the outputs from this process are displayed on an indicator; for example, an oscilloscope, the vibration pattern can be readily seen for a given phase. As the body vibration frequency is changed, the reference signal changes a corresponding amount, so that the difference signal remains at the same frequency.

The stroboscopic vibration analyzer will simplify gathering of data from any periodic process in which the amplitude and phase relations of changes are important. Characteristics of the pick-ups are the only limits to the vibration amplitudes that can be studied by this method, and simply by changing the oscillator, frequencies of any range can be analyzed.

Seek Non-aircraft Uses for Gas Turbines

WASHINGTON—One result of a recent conference of gas turbine manufacturers and Pentagon officials may be a relaxation of military specifications to provide for bids from gas-turbine engine builders. In many cases, military specs—say, for radar stations—are geared to conventional powerplants, and make no provision for the installation of gas turbines.

The conference brought the state of the art in non-aircraft gas turbines to the attention of so many procurement officials that it's inevitable such specification restrictions will be lifted. Army engineers are now evaluating GM-Allison's 605-lb, GT-305 engine for use in air-transportable earth-moving equipment.

Metric System in Effect in Japan—at Last

TOKYO—Japan's shift to the metric system went into effect the first of this year—nearly 40 years after the government decided to adopt it in 1921. However, it still would not have gone into effect had it not been for the leadership of the US occupation group.

The metric system was a long-dead issue before World War II, and was branded as unpatriotic by ultra-nationalist groups and military cliques. Ironically, however, Japan's prewar Army and Navy used the metric system right along. After the war, Occupation General Headquarters persuaded the Japanese Government to go ahead with the metric system. It was applied in the rationing of rice in 1951. At that time government decreed that system would be put into effect Jan. 1, 1959.

This January the system automatically went into effect without much ado. Japanese above 36 years of age were puzzled because they were not trained for it. But those under the 36-year bracket took to the system which had been taught in the schools despite the antagonism to it.

The new system is now used to the extent of measuring business transactions, and on all kinds of certificates and public data. Policymakers attributed its success first, to the general headquarters authority; second to the Japanese scientists who strongly advocated promulgation of the metric system to make technological measuring easier; thirdly, the 30-year training period for the metric system; and lastly, the scale manufacturers went all out to do away with ancient system which could not be used outside Japan. So far, metric scales are manufactured for domestic use only but a spokesman of the Machinery Export Association said that there already are some enquiries from Southeast Asian countries where there are no maintenance facilities.

New Honeycomb Brazing Meets Quadrupled Needs

Los Angeles—To meet the need for unprecedented quantities of stainless honeycomb sandwiches for use in high-speed aircraft flown in the "thermal thicket," North American Aviation instituted 28 methods-management programs which, performed simultaneously, are enabling NAA to keep pace with its 1959 production schedule. More than four times the usual amount of stainless honeycomb (the B-58 requires 850 sq ft) is being used in NAA's F-108 continental defense interceptor, and the B-70 chemically fueled bomber; both are in the over "2000-mph speed class."

Initially, NAA engineers decided that no one method of brazing would satisfy all design requirements; large, flat structures (wing panels), rounded shapes (ducting), and irregular tapered pieces (tail surfaces) defied a single brazing approach.

The stainless steel alloys used for the skin require heat treating to develop their full strength. If possible, heat treating should be combined with brazing to eliminate possible remelting of the brazing alloy. Engineers learned that the original age-hardening cycle of heating to 1750 F, cooling to room temperature within five min, an 8-hr soak at −10 F and reheating to 950 F for one hour could be altered considerably without impairing properties. New program calls for 1625 F max, cooling to 1000 F within 45 min. This rapid cooling is critical, but there is some leaway—three hr at −110 F and eight hr at 900 F. Such a schedule can be combined with brazing.

A silver-lithium brazing alloy has been substituted for the previously used silver-manganese alloy. With a brazing range of 1610 to 1700 F, it is compatible with the base metal, has excellent corrosion resistance, excellent flowing properties, is self-cleaning so that less rigid atmosphere control is needed, and is readily available in supply.

NAA engineers next examined the practice of sealing the honeycomb into a welded-shut retort with graphite to serve as a heat-sink in order to even out heat distribution; a technique that segregates the graphite to prevent its gases from contaminating the alloy.

Node flow has been another troublesome problem. When heated, the brazing alloy is attracted by capillary action into the cracks of the honeycomb core, reducing the amount that is left to form a bond at the interface between the core and the suface skin.

Several possible solutions to this problem are being investigated. Capillary attraction can be reduced by oxidizing the core by applying a very tight control of time-temperature, or by using a slower flowing brazing alloy. The run-off problem is most pronounced in curve sections where the alloy tends to drain downhill and collect at the lowest point.

Meanwhile, NAA engineers saw fit to obtain test structures such as wing box, dive brake, duct, elevon, from outside sources. Purpose was to get a comparison of standards as well as to take advantage of another's progress.

For example, one concern built its reputation as a leader in honeycomb fabrication by turning out the largest stainless sandwich panel ever produced —a 6-ft by 12-ft panel within a 49-hr brazing cycle. Soon after, NAA, applying new techniques and equipment, turned out a 10-ft by 14-ft panel within a 12-hr brazing cycle. Yet NAA engineers hasten to add, "We want to encourage anybody and everybody who can come up with a better brazing method."

Quality control and non-destructive inspection methods have also come under close scrutiny for cost and reliability improvements. Slow and expensive X-ray inspection has been replaced by fluoroscopy, the part being automatically manipulated. This is easier than providing the extensive

Shooting for the record . . .
Marksman at US Army Combat Development Experimental Center, Fort Ord, Calif, (left) fires new lightweight, high-velocity Armalite rifle, capable of 700 rounds per min. Made of aluminum alloys and plastics, the Armalite weighs 6.85 lb, fires a .222-cal cartridge. Effectiveness of experimental weapon is registered on automatic event recorder (right) which can service 20 targets. Solenoids attached to targets transmit hits electronically to the recorder. Armalite, along with the Army's M-14 rifle and its Winchester model, is being tested here to determine effectiveness of individual weapons as related to squad organization, fire techniques and logistics.

X-ray shielding necessary if the operator moved and the work was stopped. When the operator spots a possible defect, he can take X-ray photos from his window.

NAA is also partial to ultrasonic inspection. Soundwaves are used to trace the pattern of the bond area on a view-screen as the pickup head automatically follows a pattern that will cover the entire honeycomb area. Newest device is a facsimile recorder that draws a permanent full-size record of the inspected area. At present, the piece must be completely immersed in a tank for inspection, but equipment for maintaining through-water contact only at the point of inspection is being developed.

Currently, NAA is relying on four methods of brazing (1) the relatively conventional furnace brazing cycle uses a luminous-wall furnace in which the air-gas mixture is pumped through the porous brick walls, igniting the inside furnace to form a continuous sheet of flame. Fast internal heating and cooling can be obtained, and the furnace can be cycled without damage since the gas flow tends to keep the brick walls cool; (2) other parts are heated in a furnace kept at a fairly constant temperature — fast cooling and excellent dimensional control are obtained by "quenching" the part in a close-fitting graphite die; (3) irregularly-shaped parts can be brazed with an electric blanket fixture which generates heat directly where needed by means of strip heating elements (see PE, Mar 16, p 29); (4) or small irregularly shaped parts can be handled in a salt bath which gives even, rapid heating.

A trichlorethylene bath is used for post-brazing treatment. Carbon dioxide bubbles through the bath, cooling it to cold-aging temperature. END

Universities Offer Engineers Rash Of Summer Refresher Courses

NEW YORK—Summer school sessions tailored for working engineers have become increasingly common in recent years in the nation's universities and technical schools. Such sessions are short—usually a week or two—and offer an intensive survey of latest developments in an engineering specialty, or fields allied to engineering. The listing below gives an indication of the geographic and subject scope of some courses scheduled for this summer.

The **Massachusetts Institute of Technology** is offering 27 short, intensive courses in science and engineering during June and July. Among these are several in mechanical engineering, electrical engineering and metallurgy. A one-week session on industrial photoelesticity (tuition, $200) for practicing engineers with no previous experience in the subject will begin June 20. And a two-week session on bearing technology (tuition, $275) will explore basic principles and new design concepts—it begins June 16. For those with persistent corrosion problems, hence need for enlarged understanding of corrosion fundamentals, MIT is offering a two-week session ($200 tuition) beginning June 22. A two-week review of classical thermodynamics and newer extensions of the subject (tuition, $275) gets underway June 29 and an examination of theory and practice of direct conversion of heat to electricity will run two weeks, beginning July 6. Also, a review of theoretical aspects of strain gages (tuition, $175) is scheduled for one week beginning July 7 and practical applications (tuition, $175) for the July 13 week.

The **Univ of Michigan** will be offering 19 intensive courses for practicing engineers and scientists. Of particular interest is the session on application of stress analysis to design and metallurgy, June 22-26 (tuition, $150). This course aims at providing engineers and designers with principles and technique for applying stress analysis to product design, material specification and service failure. Other Michigan short courses include technical writing, June 15-19 (tuition, $150) and a course, June 25-24 (tuition, $200), in automatic control for engineers who desire basic understanding of modern practice.

At the **Univ of Wisconsin**, the Extension Div will offer a few engineering courses in May and June as forerunner of its program for the fall and winter terms. A two-day course on adhesives and fasteners (tuition, $20) will run May 7-8; a two-day course on legal problems in engineering (tuition, $20) is set for May 19-20; new opportunities in plastics (tuition, $20), May 26-27; and problems and practices of consulting engineers (tuition, $20) through June 4-5.

Among the nine seminars scheduled for the **Pennsylvania State Univ** campus this summer is a survey of the mechanical properties, design and application of plastics (tuition, $85) from June 28-July 3. Other seminars will be offered in reactors and radioisotopes, June 1-26; missile systems engineering, June 7-13; underwater missile engineering, June 7-19; R & D management development, July 5-10; and technical report writing, Sept. 13-25.

Purdue Univ will offer a short course on design of experiments for engineers and others concerned with planning and interpreting results of experiments, and one on quality control by statistical method. Both courses will be offered June 9-19 (tuition, $175 each).

The **University of Calif** Extension Div will offer a range of courses on nuclear technology. A study program for engineers and scientists without knowledge of radioactivity or for persons familiar with hazards but lacking engineering skill (tuition, $800) will run June 22-Aug 28. Of shorter duration is a two-week course on Radiological Regulation and Use (tuition $225) covering nuclear science, isotopes applications and legal aspects from July 20-31 and a Nuclear Technology Survey for management (tuition $150) from July 13-17.

Rensselaer Polytechnic Institute is planning a non-credit course on instrumental analysis (tuition $150) from June 15-20.

Some forthcoming sessions concentrate on engineering management. **Cornell's** School of Mechanical Engineering will offer its sixth annual Industrial Engineering Seminars (tuition, $125) May 16-19. Covering eight major areas, the seminars will deal with industrial management, manufacturing engineering, engineering administration, small plant management,

methods and work measurement, computers in production planning, applied industrial and engineering statistics and statistical aspects of component reliability.

Digital computers will be covered by three intensive courses directed to engineers, scientists and industrial users at the **Univ of North Carolina's** Extension Div this summer Aug 17-28. An introductory course is aimed at persons interested in computers for science or data processing (tuition, $150); another covers frontier research in programming and artificial intelligence with emphasis on theory and technique for non-computational purposes (tuitions $200) and the third covers frontier research in numerical analysis (tuition, $200) with emphasis on theory and recent experience at computing centers.

The School of Engineering at **Johns Hopkins** is again offering an intensive course on operations research and systems engineering (tuition, $300) June 9-20. First three days' content is slanted toward executives; the remainder is directed toward technical personnel.

Stanford Univ is again presenting its course on creative engineering and comprehensive design (tuition, $275) June 22-July 3. The course aims to help engineers establish a balance between analysis, synthesis and evaluation that will enlarge their creative productivity. The course is primarily planned to help individual participants, though some consideration will be given individuals who wish to start creative education programs in their companies.

A short course in technical and industrial communications (tuition, $50) will be given by **Colorado State Univ** July 6-10. The course is designed for engineers, scientists and writers engaged in preparation of reports, manuals and articles. Successful participants will get two quarter credits.

New York Univ is offering three courses: Thermoelectric Materials and Devices (tuition, $110) from June 15-19; Ductile Iron (tuition, $110) from June 29-July 3 and Vacuum Metallurgy (tuition, $15) from June 1-3.

END

For additional information on any of these courses, contact the Dept of Engineering of the sponsoring schools.

FTC Relies on Technical Testimony, Turns Deaf Ear to Consumer

WASHINGTON—The Federal Trade Commission is relying on scientific testimony—and dismissing consumer testimony as of "little value"—in its false advertising case against Evis Manufacturing Co.

The Commission ordered the San Francisco manufacturer to stop claiming its water conditioner will make hard water soft, remove unpleasant odors, save soap, reduce the cost of heating water, leach out alkali and salts in soil, and thus reduce the amount of water required for irrigation.

The issue of scientific versus user testimony had been hotly contested before the Commission in the case almost two years ago. A hearing examiner ordered the case dismissed as "unproved" because of user testimony supporting the claims made by the manufacturer. The manufacturer at that time brought 92 satisfied customers into court. The original charges date back to 1954.

The water conditioner is described as "an over-sized pipe coupling with an interior cross-post integrally cast in place. It is made of cast iron or bronze or similar metals and coated inside and out with zinc galvinizing."

Recently, Dr. James Hoffman of the National Bureau of Standards testified that, on the basis of his scientific knowledge and his experience with the device, the Evis water conditioner could have no effect on water. The Commission relied on this kind of expert opinion in reversing the examiner.

The Evis case is similar to the controversial FTC case against AD-X2, a battery additive, and its manufacturer, Jess Ritchie. FTC finally decided AD-X2 was not falsely advertised and dismissed the case. The Evis case is different, says the Commission, because there was some scientific findings favoring AD-X2, while it finds none at all to support the Evis claims.

A $2-million damage suit against the government by Ritchie is still pending in the US Court of Claims. A commissioner must rule on Ritchie's suit before the court actually takes it up. Ritchie brought his claim last fall, asking for damages and legal fees involved in defending AD-X2 against Federal Trade Commission charges. The Commission finally dismissed the charges as "unproved" in 1956, asserting that consumer testimony claiming beneficial effects for the additive outweighed the opinion expressed by scientists of the National Bureau of Standards that the additive was worthless.

COMING EVENTS

APRIL

29-May 1 . . . . American Society of Mechanical Engineers, 1st National Metals Engineering Conference, Hotel Sheraton-Ten Eyck, Albany, N. Y.

MAY

4-6 . . . . American Society of Mechanical Engineers, Maintenance and Plant Engineering Conference, Edgewater Beach Hotel, Chicago, Ill.

6-8 . . . . Institute of Radio Engineers, 7th Regional Conference and Electronics Exhibit, Johnson Gymnasium, Univ of New Mexico, Albuquerque.

11-13 . . . . American Society of Mechanical Engineers, American Institute of Electrical Engineers, Institute of Radio Engineers, Joint Automation Conference, Pike Congress Hotel, Chicago.

12-14 . . . . American Society of Mechanical Engineers, Production Engineering Conference, Statler-Hilton, Detroit.

15 . . . . Society of Aircraft Materials and Process Engineers, Eastern Div, Spring Meeting, Hotel Statler, New York.

20-22 . . . . Society for Experimental Stress Analysis, National Spring Meeting, Sheraton Park Hotel, Washington, D. C.

25-28 . . . . American Society of Mechanical Engineers, Design Engineering Conference, Convention Hall, Philadelphia.

25-28 . . . . Clapp & Poliak, Inc, Design Engineering Show, Convention Hall, Philadelphia.

JUNE

4-5 . . . . Institute of Radio Engineers, 3rd National Production Techniques Conf, Villa Hotel, San Mateo, Calif.

17-20 . . . . National Society of Professional Engineers, Annual Meeting, Commodore Hotel, New York.

Young Scientists Vie For National Honors

NEW YORK—Ten youthful science prodigies have been tapped here by the American Institute of the City of New York to show their projects at the National Science Fair in Hartford early next month. The winners were chosen from among 4000 entries by students competing from schools in New York's five boroughs.

The exhibits, which were required to illustrate some aspect of pure or applied science, drew awards for demonstrating ability to solve a clearly defined scientific problem through analysis, experiment, observation and verification. Exhibitors were encouraged to use ordinary materials, to explain the experiment clearly and graphically and to show originality. Entries ranged the fields of science and technology from genetics and medicine through physics and mathematics.

Among entries selected for the Hartford Fair was a doppler radar by a 10th-grade student, Stephen Siegel. This radar detects objects by the alterations that occur in the frequency of signals it beams against a moving object. In his apparatus, Siegel mixed a constant transmission signal and a signal reflected from a moving object in a crystal diode (housed in a beer can). The resulting signal was then sent to an audio amplifier. Siegel demonstrated that his apparatus detected motions by focusing the beam on a fluorescent light. The activity of the gas molecules within the light rod were picked up by the amplifier. He also induced curious onlookers to walk past or along the path of the beam.

A 12th-grade student, William Rothman, invented a quadricator—an electric unit for solving quadratic equations of the form $x^2 \pm bx + c = 0$. His unit works for any case where the b and c terms are integers between 1 and 25. Rothman arranged circuitry of his apparatus so that an electrical contact made on one end of the board for the b value of the particular equation being solved and a contact made on the other end of the board for the c value of the equation result in the correct solutions being flashed on a panel at the back of the board.

In the mathematics division, a 10th-grade student, James Lepowsky, presented an algebraic approach to the fourth dimension. Lepowsky based his project on the premise that only through accident do we think of space in three dimensions. A straight line can be pulled into any number of dimensions. To describe a four dimension space, Lepowsky chose four quadratic equations, then graphed their interrelationships in space by an arrangement of wire. His four dimension world emerged as a heavily latticed object shaped like a distended cube with a pointed end.

JIC Hydraulic Codes Undergo Up-dating

DETROIT—Some 200 manufacturers and users of hydraulic equipment attended the recent Joint Industrial Conference (JIC) on Hydraulic Standards which was convened to consider proposed revisions to 1953 standards.

Revisions were suggested mostly by the automotive industry trying to minimize its hydraulic problems. Component manufacturers like the National Fluid Power Assoc (NFPA), in turn, suggested revisions to the revisions offered by the automotive Big Three. Sitting in judgment were builders of standard machine tools, aware that each revision makes the pumps, valves, cylinders more expensive; hence, their products. Builders of custom-made machines, however, say they favor JIC standards because they leave little room for sharp bidding tactics.

Conference participants were concerned only with standards related to performance. No attempt was made to standardize mounting dimensions or parts. Extent of revisions, however, was voluminous and detailed. Typical revision was adopting additional symbols so that circuitry of individual stations on a transfer machine could be adequately diagrammed.

In general, the manufacturers of hydraulic equipment okayed the users' revisions. NFPA executive vice president, Barrett Rogers, said his organization was pleased that it was notified in advance of the conference by the users as to what their revisions were.

Representatives of the machine-tool builders like Ben Bregi, vice-president of National Broach, fear expansion of JIC standards is unnecessarily increasing costs to users.

The electrical counterpart to the hydraulic JIC came under fire during a recent Westinghouse machine-tool forum (see p 21) in Buffalo. JIC electrical standards were criticized by some as being overly strict, entailing unnecessary expense. Proponents of JIC in both hydraulic and electrical fields counter that such standards are never compulsory except as the customer requires.

US Dept of Science Unlikely Before 1961

WASHINGTON—Senate hearings on a proposal to create a Dept of Science & Technology with cabinet status indicate a lengthy study period and no chance of action before 1961.

The proposal, a bill sponsored by Sen. Hubert Humphrey of Minn., chairman of the Senate Subcommittee on Government Operations, would put under one department the National Science Foundation, Atomic Energy Commission, National Space and Aeronautics Administration, National Bureau of Standards and the scientific research functions of the Smithsonian Institution. It would not be concerned with the military.

Proponents feel that such a department would coordinate the growing science activities now spread among a number of agencies. A secretary of science would get a better hearing on Capitol Hill when seeking appropriations than do the directors of small agencies. This point was made during opening-day hearings before the committee by Alden H. Emery, executive secretary of the American Chemical Society, in recommending a study commission.

Opponents fear that a department hierarchy might put science in a strait jacket. They warn that bureaucratic regulation would dampen the present diverse creative efforts. Lewis L. Strauss, secretary of commerce and former director of AEC, asserted that "science does not lend itself naturally to consolidation or isolation within one organization." A spokesman for Bell Telephone Lab., Dr. W. O. Baker, said we are "not yet ready" for a department at this early stage of science permeation into national affairs.

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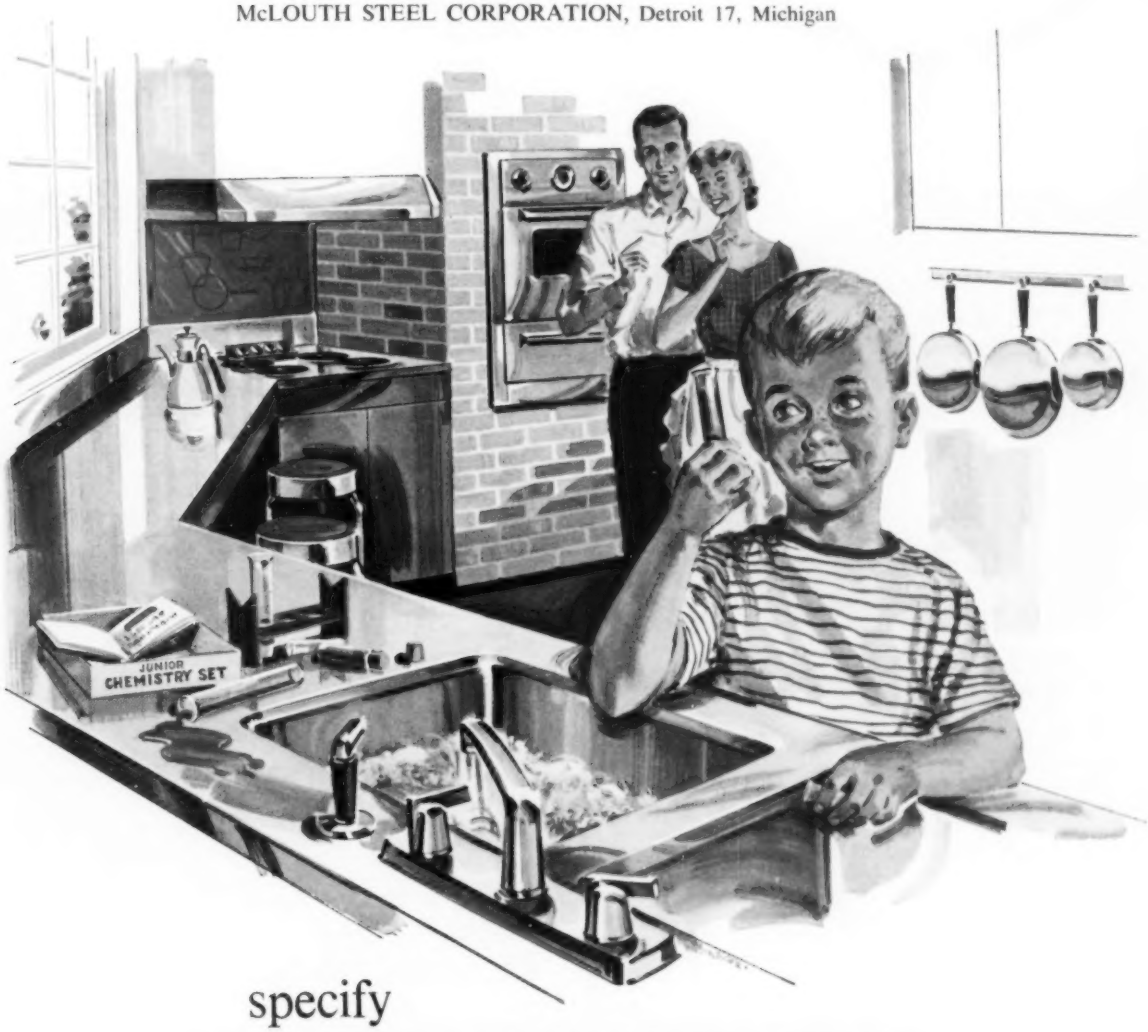

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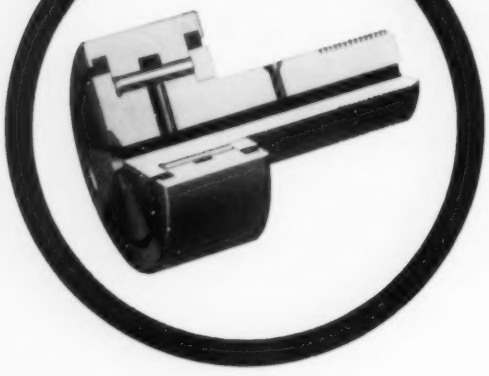
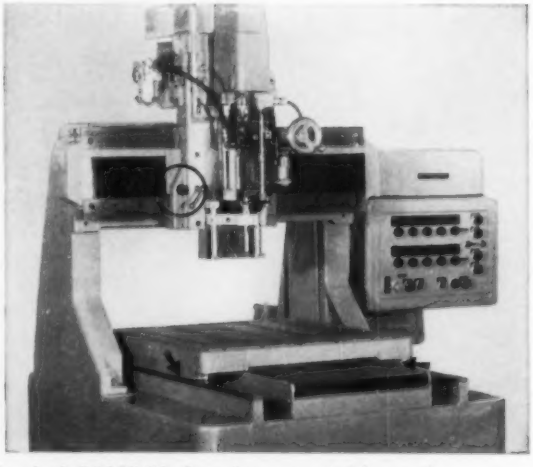


McGILL sealed CAMROL® bearings protect roller follower efficiency — prelubricated to reduce maintenance

Sealed SCF series bearings add protection from contamination to the extra performance advantages of McGill CAMROL cam followers. Specially treated labyrinth seals at the roller ends keep out moisture, dirt, chips, etc. All exposed surfaces are treated to provide a corrosion resistant black ferrous oxide finish.

The sealed construction with a channeled grease reservoir in the outer race bore eliminates need for frequent relubrication. Maintenance is reduced and can be eliminated in inaccessible mountings. Specify standard bearings and avoid building up followers with extra seals.



Sealed CAMROL bearings as table and crosshead rollers in tape-controlled Hillyer drilling machine

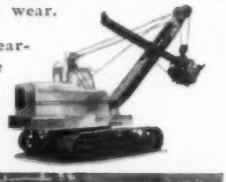
CAMROL bearings provide smooth, accurate motion as load carrying rollers for table and crosshead motion of this tape-controlled, precision drilling machine manufactured by HILLYER CORPORATION. Use of these bearings has simplified construction and improved accuracy. They have eliminated the manufacture of shaft and retainer assemblies and increased load capacities. The corrosion resistant finish has also eliminated the need for plating bearings. Ball bearings formerly used cracked under the same loads. Operating speeds are 400 RPM and loads are 2000 pounds. The bearings are prelubricated and sealed to keep maintenance at a minimum.

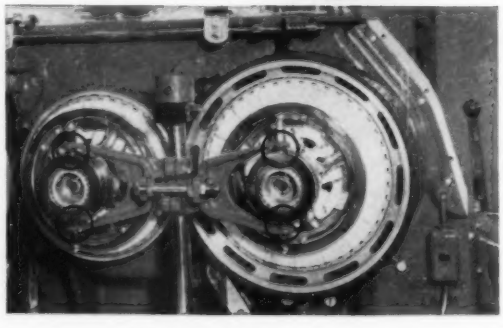
Sealed CAMROL bearings replace bronze rings in shovel clutches

UNIT CRANE & SHOVEL CORPORATION is using SCF SEALED CAMROL bearings in clutch shifter yokes in their ½ and ¾ yard power cranes and shovels and Model 360 MARINER 30-ton cranes. Shown is a closeup of two of the five clutches which control the hoist drum and the hold drum and various actions of the machines. The bronze collars formerly used were higher in initial cost than the CAMROL bearings. Their use also required considerable machining and the addition of component parts such as bolts, spacers, etc.

The CAMROL bearings in this application promise better, more accurate control than the bronze shifter rings which tend to become "sloppy" with wear.

The integral seal feature of the bearings protects their performance under field conditions and reduces relubrication requirements.





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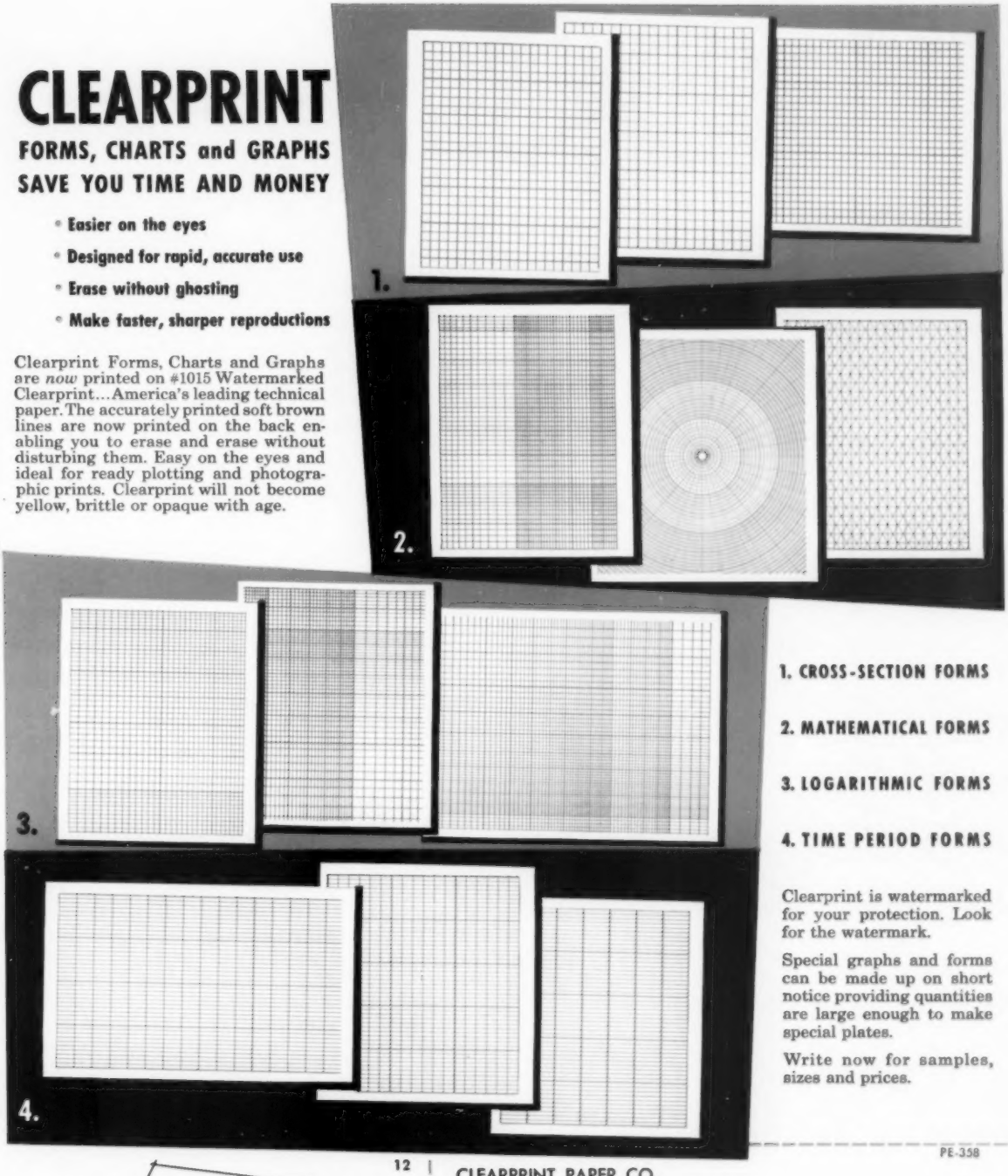

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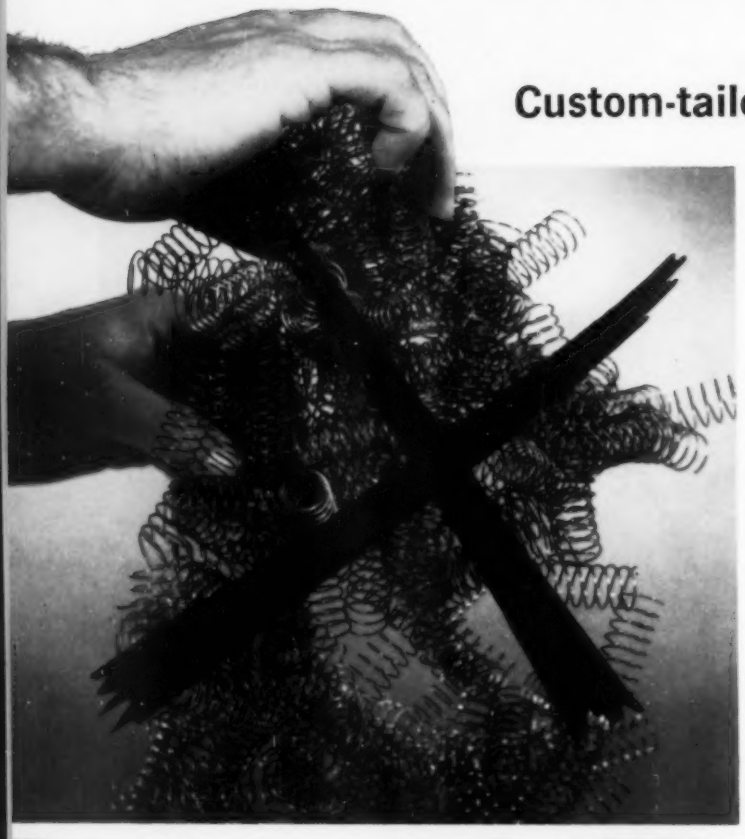
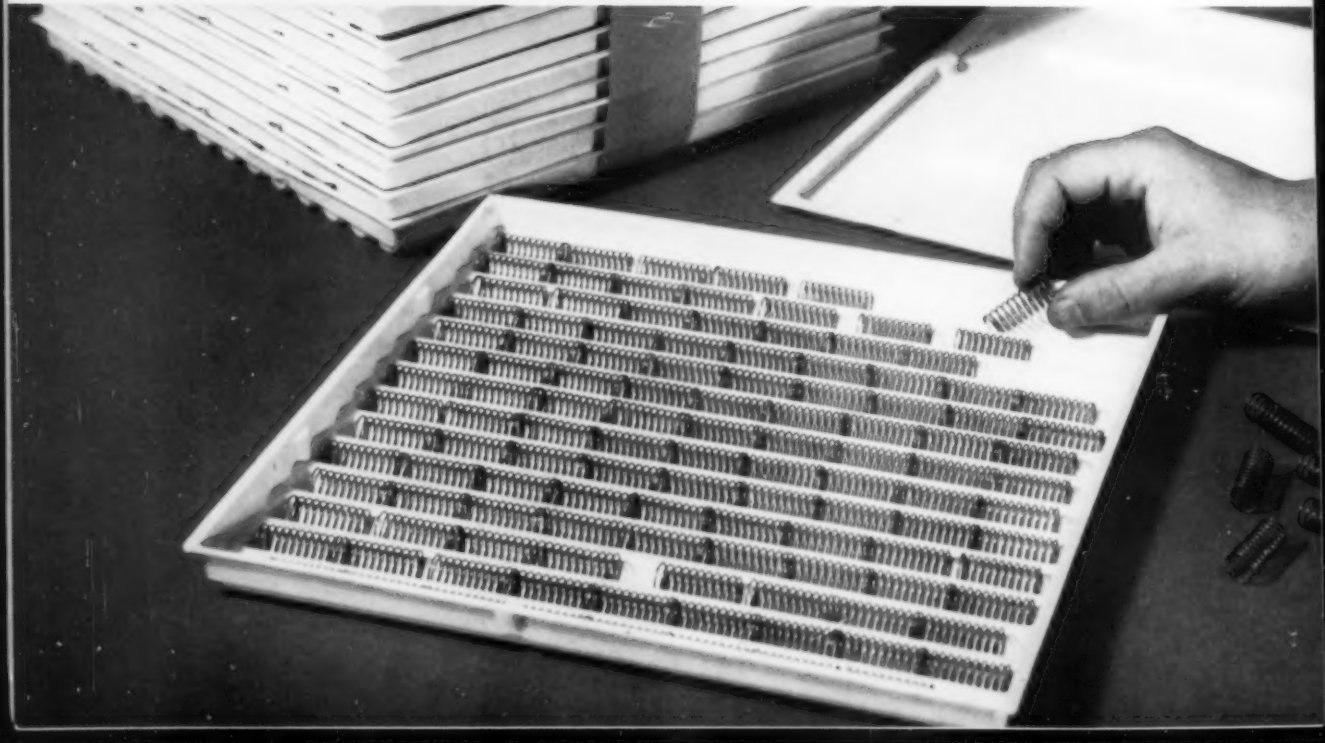
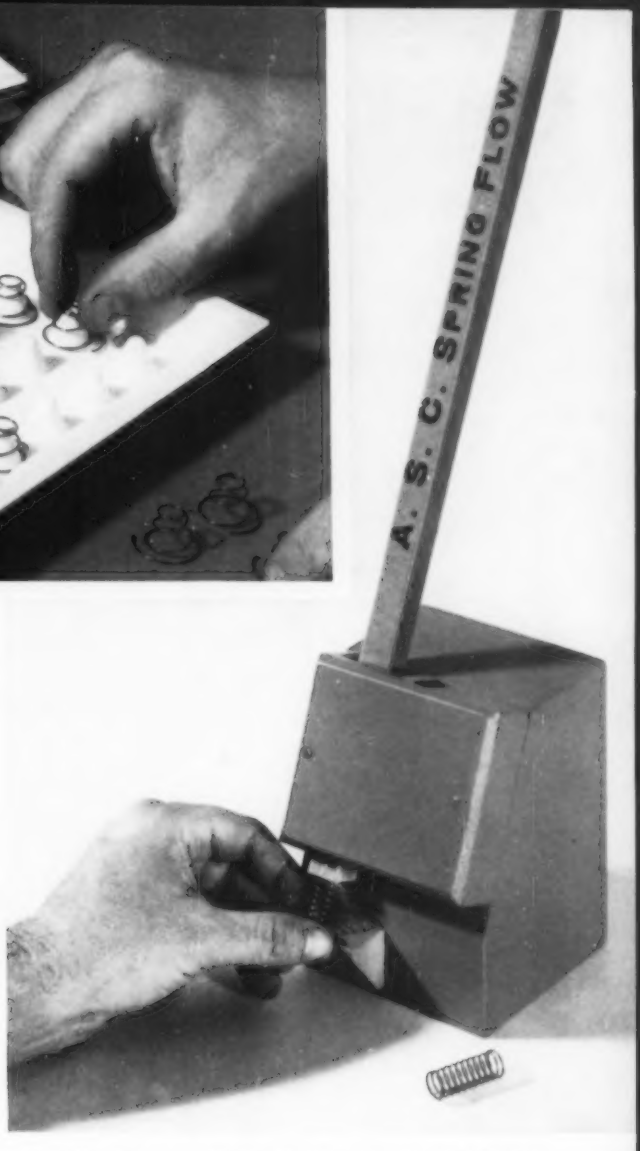


Custom-tailored packaging of springs that cuts costs and speeds operations in your plant

Spring Flow is a systematic approach to the problems of handling and storage of springs, wire forms, small stampings, in customer plants. It overcomes time-wasting tangling, and the distortion that often results from tangling. It can be engineered for specific applications to expedite hand or automatic assembly.





Spring Flow lowers handling and assembly costs — eliminates distortion — protects finish

Spring Flow makes use of a variety of modern materials, dispensers, containers. The extent to which it may be applied depends on the complexity of each individual part and handling requirements. The cost of Spring Flow is frequently offset by resulting savings.

The potential benefits of Spring Flow almost defy imagination. Ask for a Spring Flow proposal for your springs or other fabricated-metal products. Or find out more about this exclusive service by writing for the new booklet—"Spring Flow."

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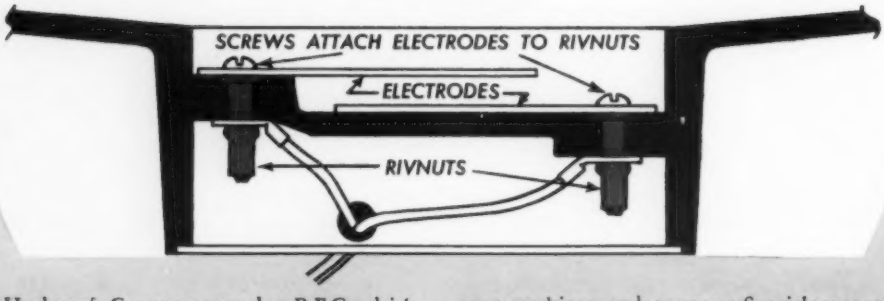


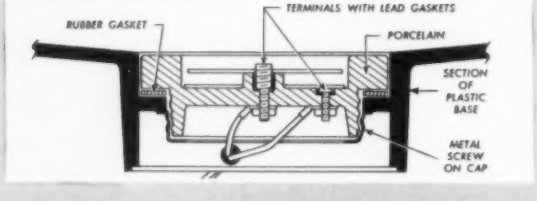
Here's why Hankscraft Company turned to B.F.Goodrich Rivnuts when they streamlined design, production and appearance of the Model 200A Baby Bottle Sterilizer.

Before Rivnuts, the electrodes and terminals were fastened to a large porcelain "dish" by screws and nuts. Four gaskets were required to prevent water leakage. A metal screw-on cap had to be fitted underneath the porcelain "dish". *(See small sketch)*

Rivnuts eliminate all these cumbersome pieces. Installed in the simplified plastic base, Rivnuts secure terminals, provide water-tight nut plates. Two screws attach electrodes — and the unit is complete.

You can get B.F.Goodrich Rivnuts in thread sizes 4-40 to ½"-13 with flat or countersunk heads. Rivnuts have hundreds of applications in appliances, electronic equipment, machinery and structures. Special types are available for aircraft and missiles.

Write now for free copy of the Rivnut Data Book. Better yet, send us a sketch of your toughest fastening problem. *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Akron, Ohio.*



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SILICONE NEWS

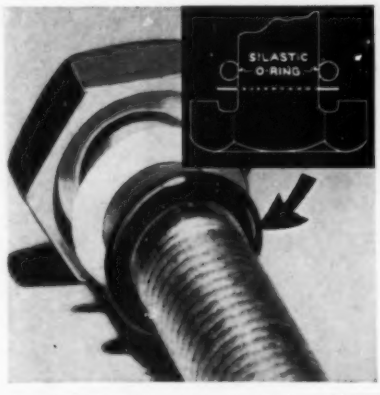
for design and development engineers • No. 61

FASTENERS SEAL FUEL

The new ABSCO fasteners developed by Aero Bolt and Screw Company, Inglewood, California, represent an unusually effective solution to the problem of bolting and sealing airborne fuel tanks to airframes.

A small Silastic® O-ring in a groove under each bolt head makes the ABSCO fasteners liquid-tight. What's more, the O-ring maintains a positive seal over a wide temperature span despite contact with fuel that would quickly ruin ordinary rubber.

A thin Teflon washer between the bolt head and O-ring reduces friction during installation of the fastener and permits the O-ring to flow evenly in all directions under pressure. With maximum shear and tensile properties, the fastener can be used over and over again without lubrication or danger of galling . . . and without need for O-ring replacement. *(Cont. Pg. 2)*



SILICONE COATING ELIMINATES WASTE

"Squeezing the bottle" or shaking it, in futile attempts to drain clinging contents, have been outmoded by silicone coatings. Perhaps this silicone property as applied by Eli Lilly and Company will help you solve a similar problem.

Lilly and Company has used Dow Corning 200 Fluid since 1951 to coat the inside walls of glass vials for aqueous penicillin and for dry antibiotics to which water is added at the time of use. The coating of silicone is simply sprayed into the glass vials and cured to a dry nonoily coating while simultaneously sterilizing the bottle with dry heat.

The photo demonstrates the efficiency of the silicone coating. None of the contents clings to the vial's walls. This means Lilly no longer needs to over-fill the vials to assure physicians a full measure. Another benefit: the silicone treatment makes it easier to stopper the bottles and helps speed processing.

Tasteless, odorless, colorless and physiologically harmless, Dow Corning silicone fluids are widely used in the pharmaceutical industry as coatings for antibiotic vials. They impart a high degree of water repellency that makes possible more complete, cleaner drainage.

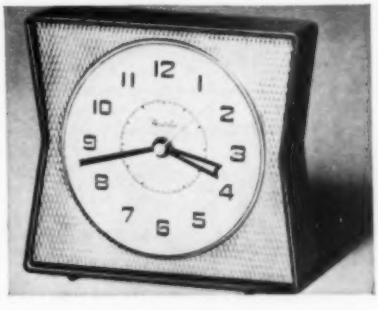
This same coating has also been used to good advantage on blood transfer equipment used in surgery, on clinical and analytical ware, and on glass and ceramic electrical insulators for industrial instruments and electronic units. **No. 623**

TIMELY TIP ON LUBRICANTS

Specifying a durable silicone lubricant can be that final design touch which assures superior performance and greater customer satisfaction. Westclox Division of General Time Corporation furnishes a nice illustration of this fact.

Six years ago, during their search for better, longer lasting lubricants, Westclox tested and began using Dow Corning silicone lubricants. Today Westclox lubricates all its electric clock motors with Dow Corning 44 Grease. Reason: the silicone lubricant remains effective long after the best organic greases have oxidized or gummed.

Lubricated with nonoxidizing, nongumming silicone grease, Westclox clock motors are always ready for instant "starts" regardless *(Cont. Pg. 2)*



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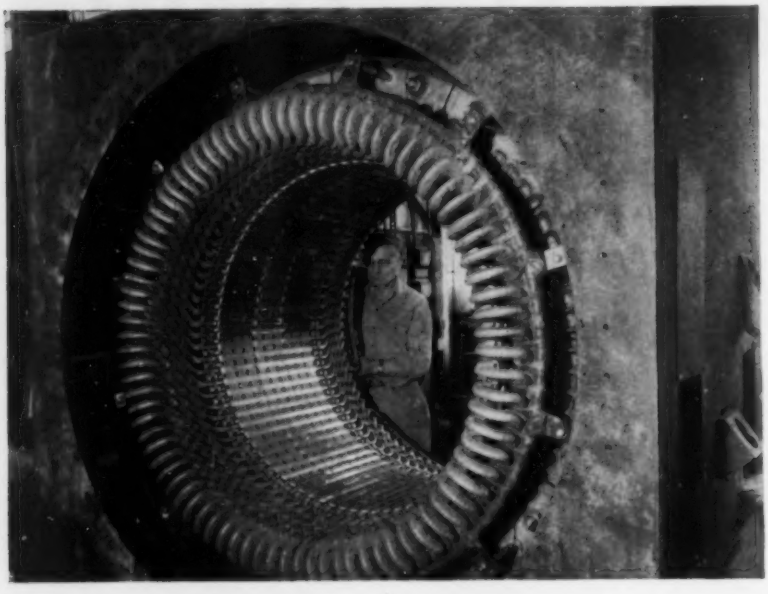

VOLTAGES GOING UP

Combining high temperature resistance with self-protecting qualities, silicone rubber insulation systems are winning increased acceptance for electrical equipment subjected to moisture, heat or thermal cycling. Example, this 11,000 volt, 3,000 hp Allis-Chalmers type AKG sintering-fan drive motor.

Insulation systems made of Silastic®, the Dow Corning silicone rubber, are being designed for increasingly higher voltages. Because of outstanding performance from similar motors designed for voltages ranging from 240 to 6,600, a midwest steel mill has specified an 11,000 volt Allis-Chalmers motor with a Silco-Flex insulation system to drive a sintering-fan.

Vulcanized in place on the motor coils, silicone rubber forms an homogenous insulation jacket that is impervious to moisture and other contaminants. Resilient, it is unaffected by thermal cycling.

When specifying drives, consider all the advantages of silicone insulation. *No. 624*

LUBRICANTS *(Continued)*

of how long they've been in storage. Increasing shelf life helps keep warranty costs low and customer satisfaction high.

In addition to assuring longer, more dependable service, the heat-stable silicone grease keeps gear hum and other motor noises to an absolute minimum regardless of temperature changes. Stored in a reservoir between two bearings, the silicone grease is distributed by rotation of the motor shaft. One pound of Dow Corning 44 Grease lubricates about 1000 clocks!

This lubricant is used with equal effectiveness on metal pinions, plastic drive gears, and brass sleeve bearings of clocks, timers and instruments. *No. 625*

O-RINGS *(Continued)*

ABSCO fasteners are available in all popular head types and sizes. They have passed military requirements including: exposure to aircraft fuels MIL-H-3136, Types I and III at pressures ranging from —14 to plus 100 psi and temperatures varying from —65 to plus 135 F. *No. 626*

new literature and technical data on silicones

Superior Performance is provided by silicone fluids in a wide variety of applications because of their heat stability, oxidation resistance, relatively flat viscosity-temperature slope, good dielectric properties, and many other desirable characteristics. A currently revised data sheet contains new information about the family of Dow Corning silicone fluids that help you specify the product best suited to your application. *No. 627*

Do You Know How silicone resins, rubber, oils and greases are being used to advantage in appliances? A six-page reprint from Electrical Manufacturing relates how extreme temperature resistance properties of silicones have been used in the designs of toasters, refrigerators, irons, portable power tools, percolators and other appliances. *No. 628*

Your Nearest Source of silicone insulating components is listed in a new data sheet. These distributors offer insulating materials which enable you to design electrical equipment with increased life and reliability, increased power per pound. A handy, complete listing of the silicone insulating materials and other Dow Corning Silicones that are available from coast to coast can be yours by writing for ---------- *No. 629*

Adverse Environments are no problem to the designed performance of your equipment if Dow Corning 3 Compound is specified. This silicone dielectric functions as a potting, filling, coating or sealing compound for electrical and mechanical parts. It continues to insulate and lubricate at both high and low temperatures. The unusual stability of 3 Compound, even when exposed to corrosive atmospheres, weathering, most chemicals and oils, is discussed in an illustrated pamphlet. *No. 630*

More Muscles for Tomorrow, a full color-sound movie, lets you see for yourself the benefits of silicone electrical insulation — increased life and reliability, greater overload capacity, and savings in space and weight. Get a folder explaining how to arrange for a showing by circling— *No. 631*

Silicone Molding Compounds are the subject of a four-page comprehensive brochure. Illustrations, tables and graphs demonstrate the outstanding physical and electrical properties that are readily utilized by designers of molded, integral parts for so many mechanisms. *No. 632*

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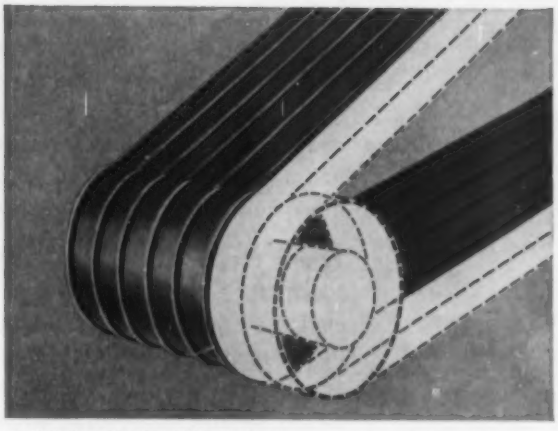

5 BELTS DO THE WORK OF 7 in a typical drive using premium V-belts reinforced with DACRON. Great strength of DACRON allows freedom of design with fewer or smaller belts and sheaves . . . creates a compact, efficient drive.

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USS Shelby Seamless Steel Mechanical Tubing offers you extraordinary freedom of design in a wide range of products from bushings to hydraulically operated telescoping booms. And, Shelby Seamless Tubing helps cut processing costs, because it eliminates drilling operations; enables you to replace drills with simple, less expensive boring tools, and it reduces tool wear and tool changes; and, more important, more uniform parts can be turned out by the hundreds or thousands.

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And, of course, the name Shelby is backed by the world's largest and most experienced manufacturer of seamless tubing—National Tube! The production of Shelby Seamless Tubing, from ore to finished product, is entirely controlled by one organization. There is no divided responsibility. Every foot, every length, is made under the careful supervision of skilled men with years of tubemaking experience. For more than 60 years, Shelby Seamless Tubing has been first with men who want the best in mechanical tubing.

You'll find Shelby Seamless Tubing available at select Shelby Distributors throughout the country. These distributors are strategically located and expertly trained in solving all types of tubing problems. Here, you can choose from a complete range of sizes and stocks. If you'd like to find out how Shelby Seamless Tubing can be most effectively applied to your designs, contact your nearest Shelby Distributor . . . *soon!*

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Clark simplifies axle machining with

DAYTON SEMI-BONDED BUSHINGS

Here's an example of how "Engineering in Rubber," the Dayton way, is used on Clarklift fork trucks. It's a unique viewpoint on the application of sound engineering principles to discover a newer, simpler, more economical way to make rubber do a bigger job for your design.

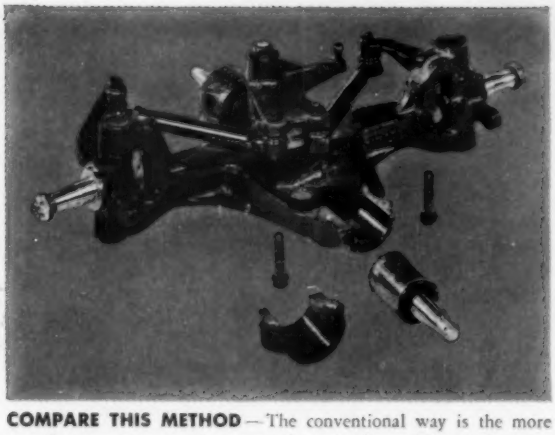
Clark Equipment was doing a good job with the rubber bushings on which the steer axle pivots. But there's always a better way and, working with Dayton engineers, Clark found it.

Look at the results . . . a new Dayton semi-bonded bushing. Delivered ready for assembly, it eliminates a separate bushing cap, an expensive boring operation, plus assembly time before and after machining.

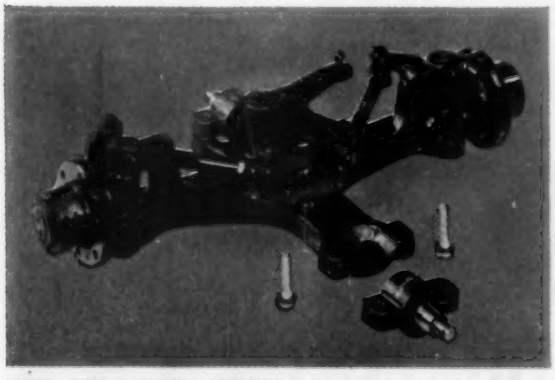
Yet there's no functional difference between this and the older type bushing. Dayton did improve the characteristics by adhering the rubber to the inner metal shaft with a lifetime bonding process . . . reducing the level of pre-compression by nearly ½ in a bushing which must permit up to 3" of articulation in the pivoting axle.

This is what Dayton means by "Engineering In Rubber." It's a design approach that can solve your problems of vibration, shock, and noise control . . . correct inherent misalignment . . . simplify assembly . . . and reduce maintenance costs. The result is better quality at a competitive price.

Fill out and mail the coupon below. It will bring you the prompt, efficient services of a molded products specialist and start you on the way to new savings.



COMPARE THIS METHOD—The conventional way is the more complex way to mount the steer axle to the frame. First the bushing cap must be shimmed and bolted down, the inside diameter bored, the cap disassembled and the shims removed, and the cap replaced again when the bushing is finally installed.



WITH THE DAYTON METHOD—Delivered ready for final assembly, the Dayton semi-bonded bushing is easily bolted into place rapidly and efficiently. Notice, too, how the axle casting has been simplified now that in-line boring is no longer required.

RUBBER · RUBBER-TO-METAL · RUBBER-TO-FABRIC

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MOLDED PRODUCTS SALES DIVISION • Three Rivers, Mich.

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THE DAYTON RUBBER CO., MOLDED PRODUCTS SALES DIV. THREE RIVERS, MICHIGAN

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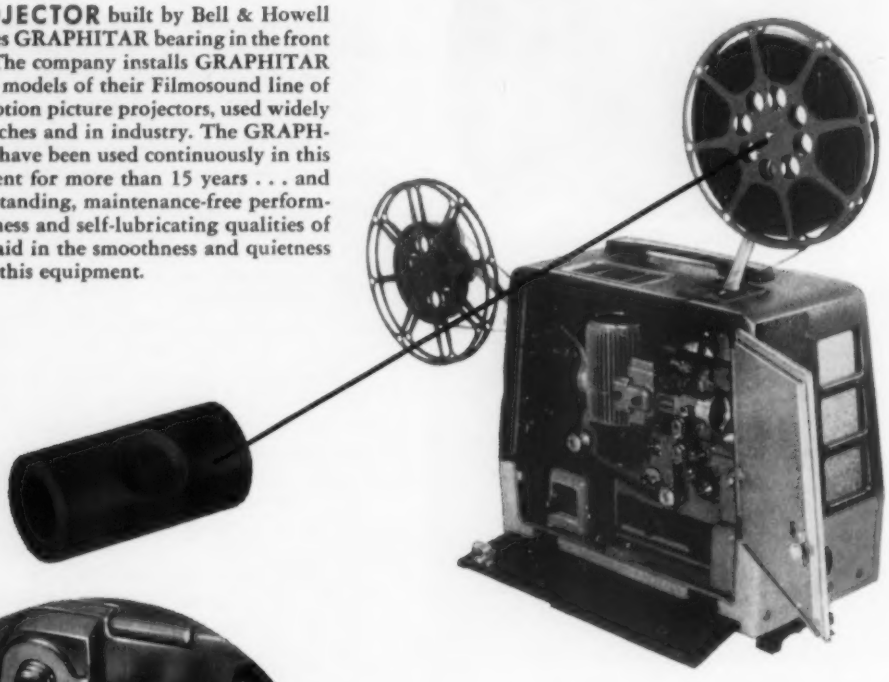
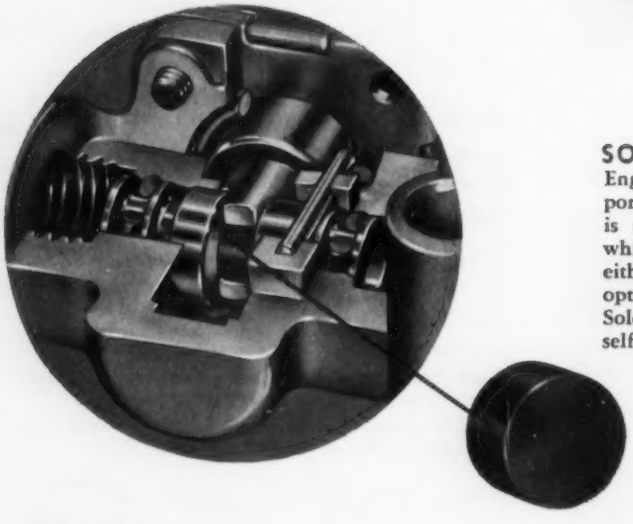
(CARBON-GRAPHITE)

successful in a wide variety of applications

MOVIE PROJECTOR built by Bell & Howell Company utilizes GRAPHITAR bearing in the front reel assembly. The company installs GRAPHITAR bearings in five models of their Filmosound line of 16mm sound motion picture projectors, used widely in schools, churches and in industry. The GRAPHITAR bearings have been used continuously in this line of equipment for more than 15 years . . . and have given outstanding, maintenance-free performance. The hardness and self-lubricating qualities of GRAPHITAR aid in the smoothness and quietness of operation in this equipment.

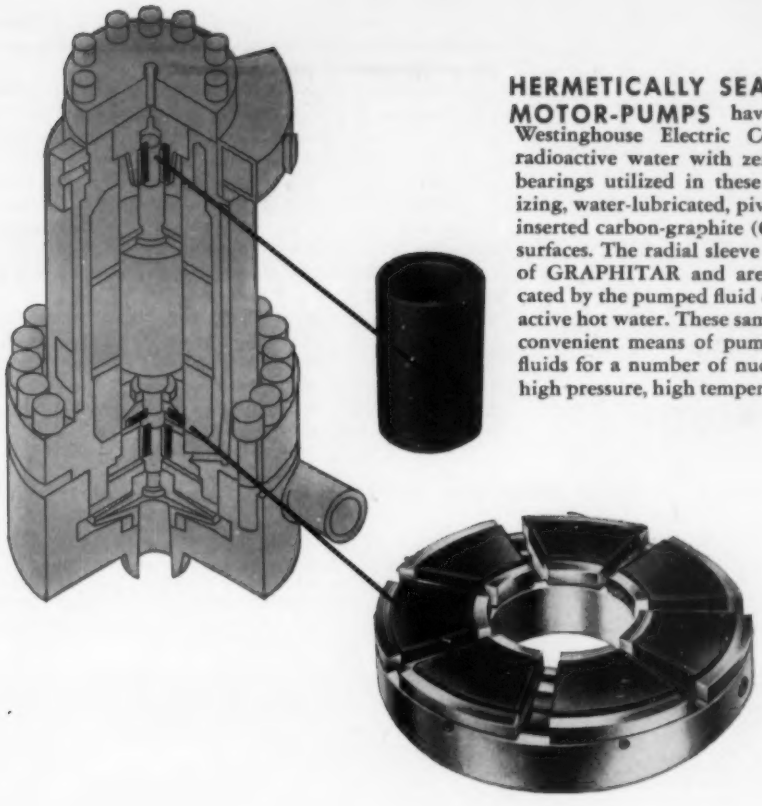




SOLENOID VALVES manufactured by Valcor Engineering Co. for use in guided missiles incorporate a floating seal of GRAPHITAR. This seal is a precise, optically flat GRAPHITAR disc which floats in the plunger. A slight pressure, from either direction, moves the disc against an equally optically flat, stainless steel seat, sealing perfectly. Solenoid valve improves with use due to unique self-lapping action of GRAPHITAR.

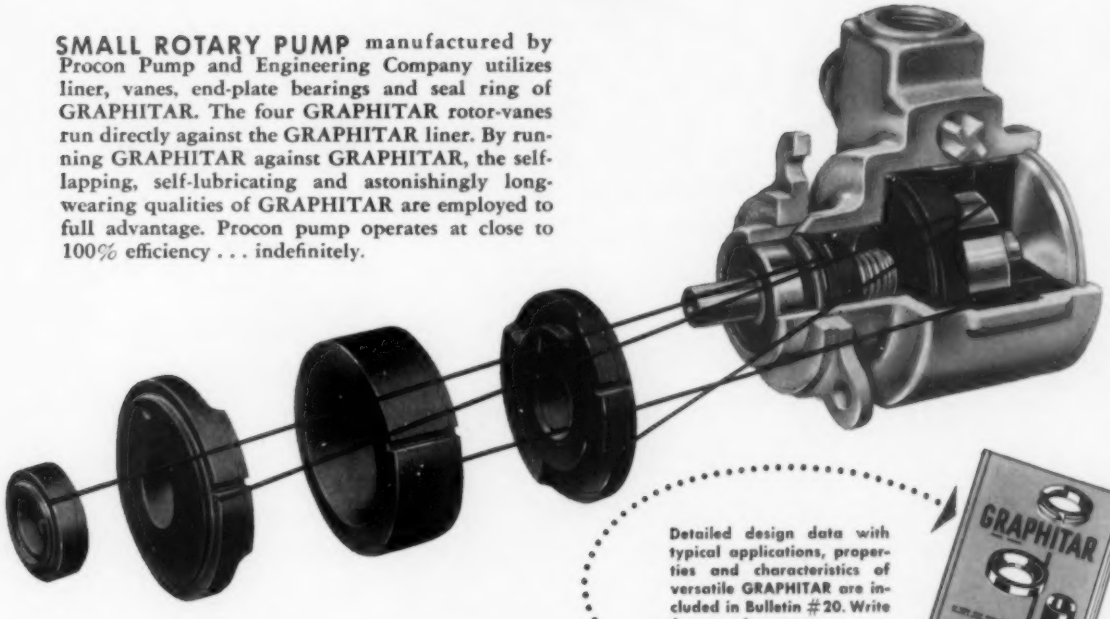
THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



HERMETICALLY SEALED MOTOR-PUMPS have been developed by Westinghouse Electric Corporation to handle radioactive water with zero leakage. The thrust bearings utilized in these pumps are self-equalizing, water-lubricated, pivoted-pad bearings with inserted carbon-graphite (GRAPHITAR) bearing surfaces. The radial sleeve bearings are also made of GRAPHITAR and are designed to be lubricated by the pumped fluid only, in this case, radioactive hot water. These same pumps have proven a convenient means of pumping high temperature fluids for a number of nuclear reactors and other high pressure, high temperature fluid applications.

SMALL ROTARY PUMP manufactured by Procon Pump and Engineering Company utilizes liner, vanes, end-plate bearings and seal ring of GRAPHITAR. The four GRAPHITAR rotor-vanes run directly against the GRAPHITAR liner. By running GRAPHITAR against GRAPHITAR, the self-lapping, self-lubricating and astonishingly long-wearing qualities of GRAPHITAR are employed to full advantage. Procon pump operates at close to 100% efficiency . . . indefinitely.



Detailed design data with typical applications, properties and characteristics of versatile GRAPHITAR are included in Bulletin #20. Write for your free copy.

R-265-2

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 1, MICHIGAN

Tone Up Your System

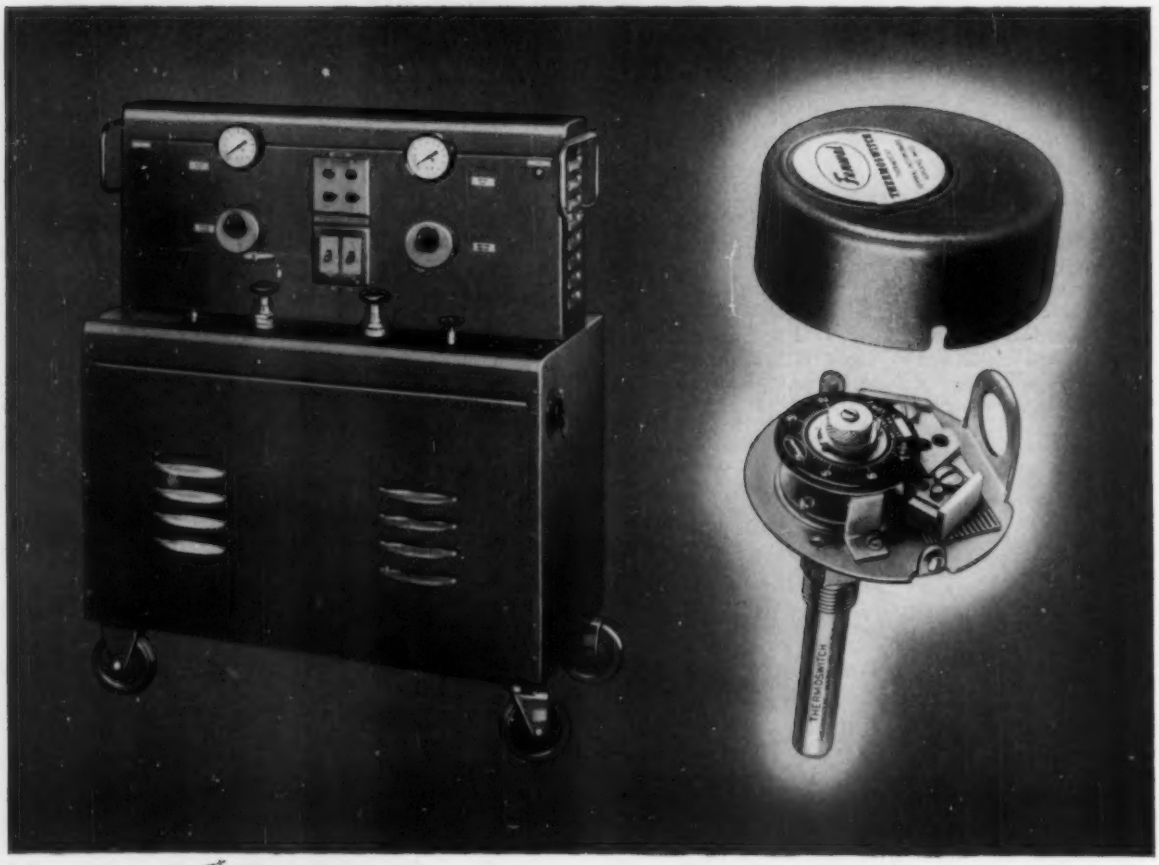
Many a manufacturer reports that installing a Fenwal THERMOSWITCH unit resulted in *immediate improvement in the performance of his equipment!*

"Immediate" is right. Rapid response is one big advantage because the outer shell is the temperature sensing member. Extreme sensitivity — within a fraction of a degree — is another. That's because the slightest movement of the shell opens or closes contacts. And within its operating range, a THERMOSWITCH unit is field adjustable, yet has a sealed tamper-proof assembly to retain its sensitivity and precision through a long, useful life. Operating range is from −100°F to 600°F . . . *three to five times that of any ordinary thermostat!*

Applications for easy-to-install THERMOSWITCH units are virtually limitless . . . not only to "tone up" existing thermal systems, but to insure the long, reliable life that industry requires. For more facts write to Fenwal Incorporated, 24 Pleasant Street, Ashland, Mass., asking for a catalog, a sales engineer, or both.

. . . *any thermal system . . . with a sensitive, precise THERMOSWITCH® unit*

In this Sterlco Control, an automatic self-contained unit for heating or cooling water to maintain a constant temperature while circulating it continuously through a plastics forming mold, "a Fenwal THERMOSWITCH unit, No. 17800 with dial and knob, fills our requirement for a sensitive, reliable, long-lasting thermostat." So says Sterling, Inc., Milwaukee, Wis.

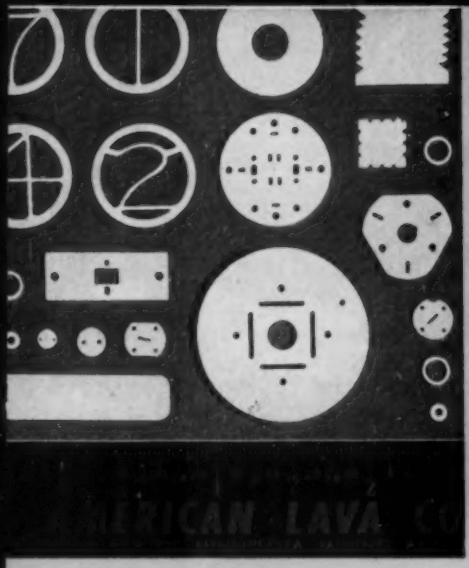


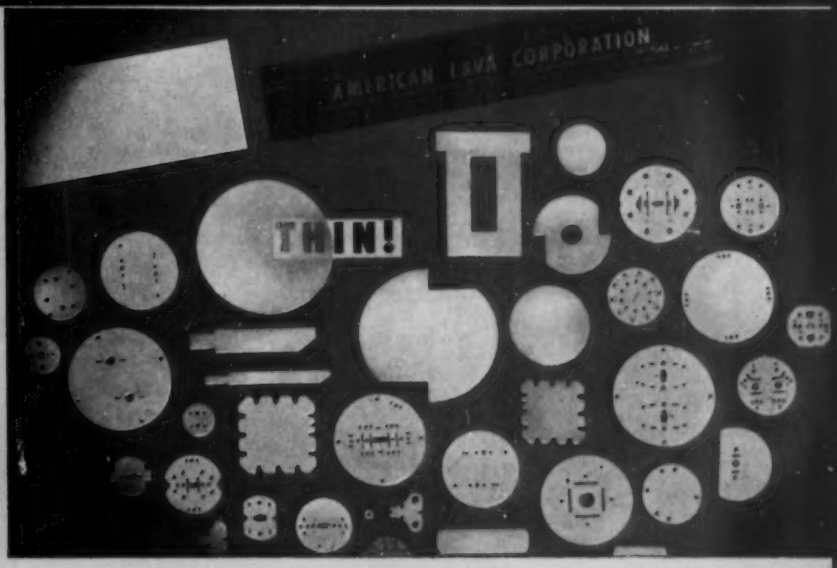
ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

NEW AlSiMag® THIN CERAMICS!

will these alumina ceramics give you

SMALLER, LIGHTER, MORE RUGGED UNITS?





Miniature AlSiMag Alumina Ceramics—some as thin as 0.005"—are being used in electron tubes, microwave windows, transistor platforms . . . as insulators in hearings aids . . . in digital counter tubes, radio crystal cages . . . in high temperature transformers, relays, fuses, micro-modules . . . high temperature amplifiers . . . and other high temperature devices including high temperature printed circuitry . . . as well as various mechanical applications.

The relatively high strength of these thin ceramics and their superior performance in high temperature, high frequency applications may help you answer the demands for smaller, lighter, more rugged units. This strength also sharply reduces damage from fatigue failure, heat deterioration, shock and vibration, and makes new automatic assembly operations practical.

Since these thin ceramics were pioneered by American Lava several years ago, demand has increased rapidly and steadily. Spurred by constantly increasing requirements, our production facilities are now capable of shipping in volume and at practical prices, small intricate shapes that were considered impossible as recently as 1955.

Free bulletin and typical samples of thin AlSiMag Ceramics sent on request

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87TH YEAR OF CERAMIC LEADERSHIP

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How NS solved another special wire problem

REMOTE CONTROL cable for jet aircraft is made of layers of high-tensile National-Standard wire wound around a stranded core. Heavy outer wire provides helix or worm-gear surface for meshing with hobbed wheels.

Photo courtesy Pan American Airlines

Special National-Standard wire helps fly new jet-liners

When the age of commercial jet transportation in the U.S. began last January, giant jet-liners inaugurated flights across the country at speeds over 600 mph. To control these new aircraft swiftly and easily requires control cables of the utmost reliability, efficiency and endurance.

NEW COMMERCIAL JET-LINERS, as well as many military aircraft, are flying now with a unique remote control cable system made of special high-tensile wire wound around a stranded core with a heavy outer wire of stainless steel wound to a pitch of 10 per inch. This outer wire acts as a helix to engage hobbed wheels within the various system control boxes.

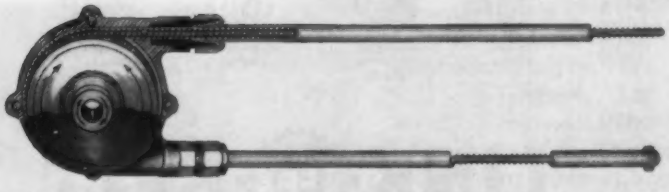
NATIONAL-STANDARD ENGINEERS worked closely with a control-cable system manufacturer to develop wire of just the proper alloy and rugged physical properties required to withstand extreme temperature and flight stress variations. National-Standard submitted wire samples to microstructural studies and physical tests to assist the customer in determining the conditions that would allow bending cable around pulleys without giving a permanent set to the cable. In addition, alloy steels with various coatings were tested to improve wear and galling resistance for various applications. The result was the development of a special stainless-steel wire that exceeded rigid specifications.

EXPERIENCED ENGINEERING HELP, of this kind, for jobs requiring high-quality wire to meet special or unique applications, is available to *you* from National-Standard. For any of the many thousands of applications where only special wire will solve the problem, let National-Standard engineers go to work for you. Write for additional information to National-Standard Company, Niles, Michigan.

Manufacturer of specialty wire and metal products

NATIONAL NS NATIONAL-STANDARD **STANDARD**

DIVISIONS: NATIONAL STANDARD, Niles, Mich.; tire wire, stainless, music spring and plated wires • **WORCESTER WIRE WORKS,** Worcester, Mass.; high and low carbon specialty wires • **WAGNER LITHO MACHINERY,** Secaucus, N. J.; metal decorating equipment • **ATHENIA STEEL,** Clifton, N. J.; flat, high-carbon spring steels • **REYNOLDS WIRE,** Dixon, Ill.; industrial wire cloth • **CROSS PERFORATED METALS,** Carbondale, Pa.; decorative, commercial, and industrial perforated metals.

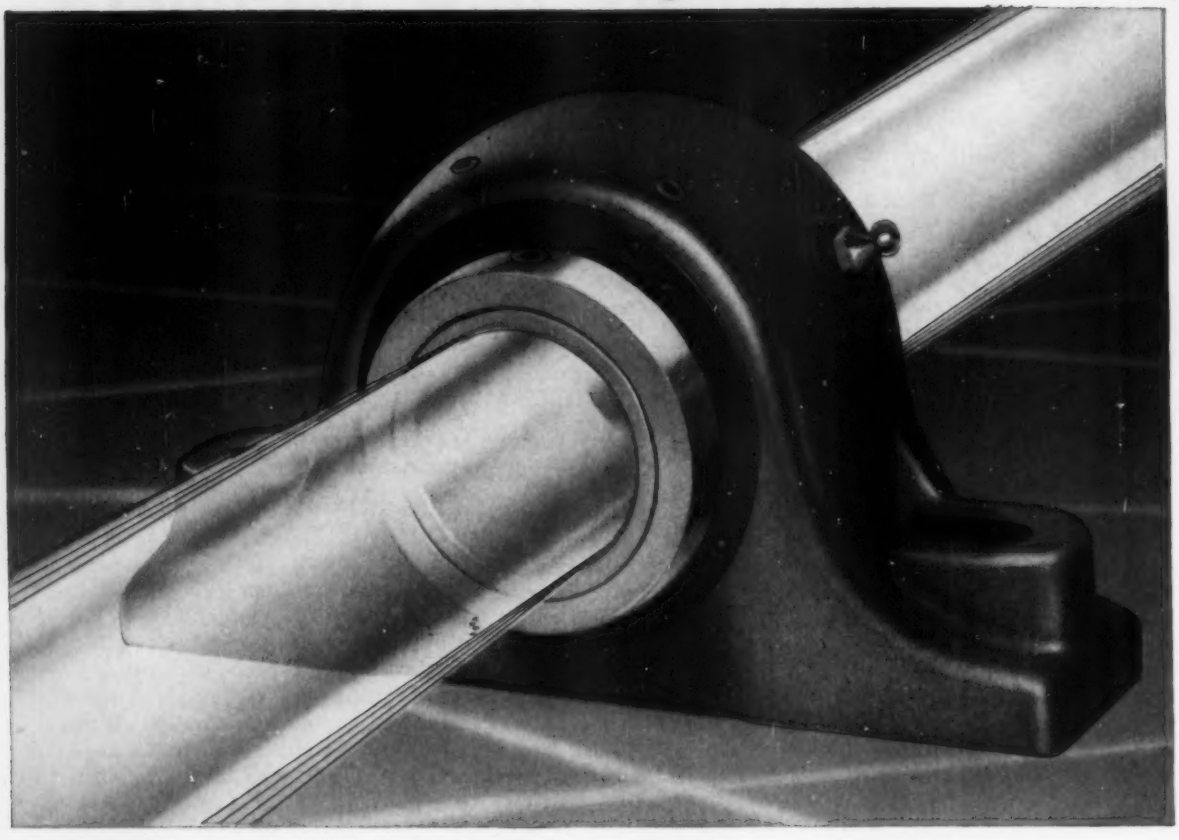


FLEXIBLE CABLE engages accurately with specially hobbed wheels housed in control boxes. This combination requires special cable wire that will not take permanent set and will provide smooth, hard bearing surface for cable inside conduit.

NATIONAL-STANDARD engineers made intense microstructural and tensile studies of sample wire to find exact physical properties of the alloy to meet strict aircraft control specifications.

CIRCLE 121 READER SERVICE CARD

Free rolling . . . long lasting because it's *Self-Aligning*



Link-Belt roller bearings compensate for misalignment of shafts and supports

Link-Belt Series 400 roller bearings have won a reputation as "the designer's choice." These self-aligning, double-row roller bearings compensate for inaccuracies in machining and assembly of equipment while maintaining full load capacity throughout their long life. Their compactness promotes simplicity of machinery design—their easy mounting reduces installation costs.

For complete information on the Series 400 —and Link-Belt's complete line of ball and roller bearings—send for our Book 2550. It's available at any one of the 40 Link-Belt offices.

Look under BEARINGS in the yellow pages of your phone book.

Also available in these mountings:

flanged blocks · flanged cartridge blocks · cartridge blocks · hanger blocks

LINK-BELT

SELF-ALIGNING BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15.113-A

PERSPECTIVES

in design and development . . .

A Tale of Two Fairs

Seven calendar weeks, 260 autobahn miles and a chasm of imponderables separate Germany's two major industrial fairs: Leipzig in the East and Hannover in the West. Leipzig calls itself the world's biggest annual fair; Hannover considers itself the more important. The Leipzig Fair is more than 800 years old, trailing back to the 12th Century; Hannover is a direct product of the post-World War II era, this year's exhibition being only its 13th. Each regards the other seriously and jealously.

Comparisons between the two are easy and difficult. The German Industries Fair just getting underway at Hannover (April 26) exudes strength, modernity and wealth from the newest restaurant to the fully transistorized digital computer. In Leipzig (Mar. 1-10), aging exhibition buldings, the dubiously reflected glory of the Soviet Pavilion replete with Lunik and Sputnik models, and the frantic posters warning of West German atomic warmongers seem second-rate. This is the easy part.

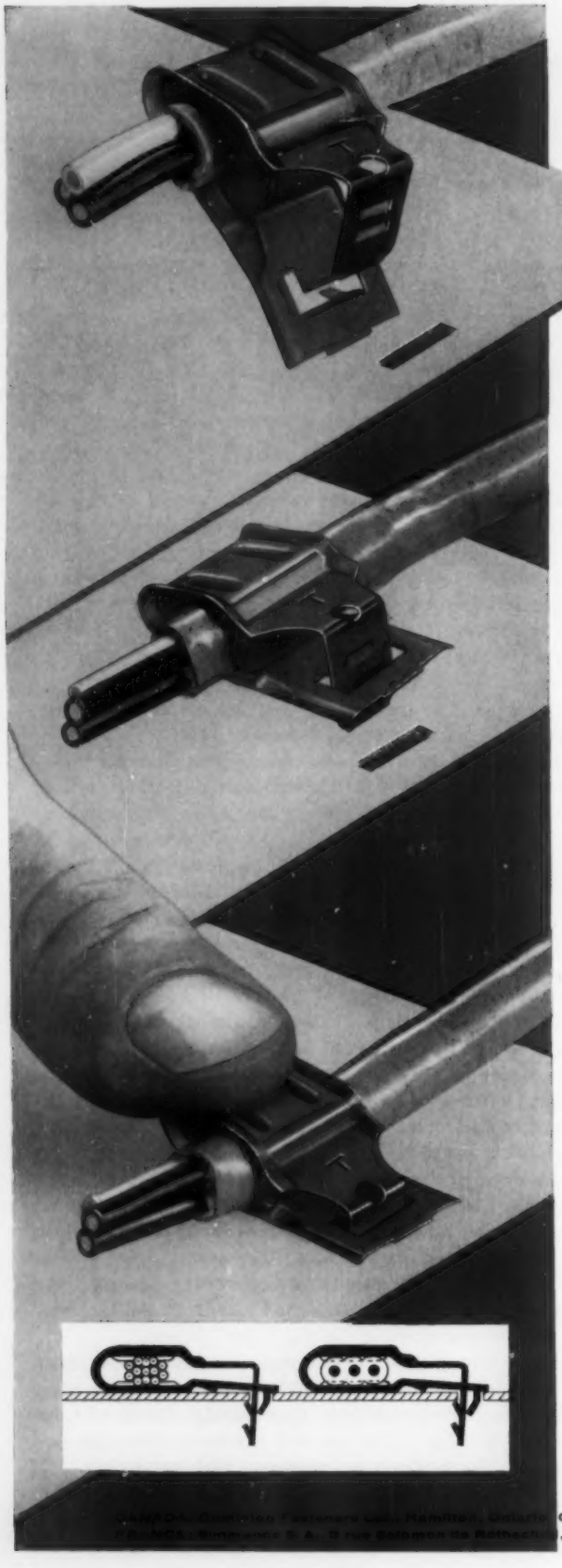
A hardheaded judgment is more difficult at the Bulgarian Pavilion of the Leipzig Fair, where an unimpressive line of Russian-style lathes squats before a mountain of apples. "Next year," says the Bulgarian official waving energetically at the apples, "we'll have drills and milling machines and new lathes standing there. No more apples."

In range and depth of technical display, Hannover is more convincing than Leipzig. A customer at the West German Fair can order anything from a precision instrument to an integrated steel plant with confidence that the contract will be fulfilled on schedule, and will meet its operating specifications. By and large, the same doesn't apply to East European suppliers, but that situation is said to be improving. In addition, bargain-basement hunting can be conducted more successfully at Leipzig because of the political complexion given to so many agreements. For example, a buyer of optical goods said that he was able to get a price 20% under the West German price for the identical merchandise, just by hinting that he might take the business across the border. For all the obviousness of advertising Leipzig as an East-West marketplace, businessmen and engineers take the slogan partially at face value and shrug off the politics of a huge red banner demanding that West Berlin be made a "free city."

From an appearance standpoint, the West Germans again this year are offering well-conceived, smartly-engineered products spreading from household durables to heavy presses and earth moving equipment, which in design can rival the best in the world. East German designers, slower in forging through a welter of bureaucracy and a lack of comprehension, finally feel they are coming into their own. "The avant garde in West Germany may be ahead of us," one East German designer explained. "But we're leading in many fields. We can standardize a product and in a comparatively short time have it accepted for the entire industry."

In East Germany, where criticism of the regime is surprisingly open, dreams of early reunification with the richer and generally more smug brethern across the Elbe have largely gone aglimmering. Boasts of Communist Party leaders that East Germany will overhaul West Germany in the 1960s are greeted by engineers and managers with wry humor.

But now these non-political men speak seriously of recognition for their part of Germany, and when they speak they are more self-confident than in the past. —Morrie Helitzer, McGraw-Hill, Bonn



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NEW SPEED CLIP® ANCHORS WIRES, CABLES, TUBING, RELIEVES STRAIN, SIMPLIFIES ASSEMBLY

Made specifically to attach cables, wires, harness, or tubing firmly to panels, this newest Tinnerman SPEED CLIP is readily snapped into place in only 3 simple steps. Prelatch it on the conductor or tubing, insert SPEED CLIP in panel hole, then push home to lock. Assembly costs are reduced because assembly time is cut to the minimum.

Tinnerman SPEED CLIPS also serve as trouble-free strain-relief clamps—they are used extensively on appliances for attaching 3-wire round or horizontal section rib cord, and easily withstand the 35-pound pull test requirements. Double latch permits pre-assembly and accurate retention of SPEED CLIPS to wire or harness before panel assembly for further savings in assembly time. Double-rib retainers grip tightly on round or rectangular cords from .175" round to .306 x .515" rectangle. Important, too, SPEED CLIPS can easily be removed from the mounting side.

Ask your Tinnerman sales representative for samples and prices. He's listed under "Fasteners" in most Yellow Pages. Or write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

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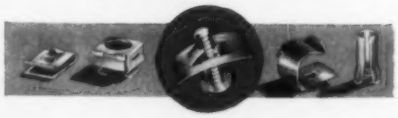

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GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. , Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

Product Engineering HORIZONS

April 27, 1959

Do-it-yourself Politics for the Engineer

Local do-gooders drum at you to get out and vote—"for your own candidate." But there is no choice; both candidates are lousy. One is elected and vindicates your opinion by putting his paw deep into the public till. Or he proves to be the monumental incompetent you suspected he was.

Your streets and sewers are poorly designed, your public buildings are monuments to politicians. Your congressman junkets around the world, making big-shot tips with your money. Or he hires his wife and local political henchmen—at your expense—to handle the state's, or the nation's, business. Or he stays in right with lobbyists, pressure groups, labor bosses, or whatever—for a consideration—position, presents or votes.

What can you do? You're only one vote, and who listens to an engineer until there's trouble? Well, we as a nation are in trouble. Many officeholders at all levels are primarily concerned with perpetuating themselves in office. Politics sometimes seems more important than people to the officeholder. Pressure groups are growing.

So maybe it's time for the analytical engineering mind to take a hand. There has been too much emotion, too much flag-waving, too much "we the Pee-pul". And not enough hard sense.

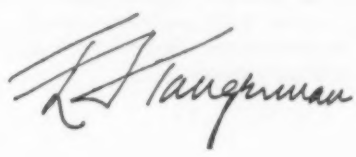
Businessmen in Syracuse (Columnist Victor Reisel calls 'em "The Boys from Syracuse") have started to do something about it. It's a non-partisan approach that goes far beyond the "Get out and vote" routine. It teaches the business of politics in seminars, provides information, ideas, tools. It is aimed at getting the businessman into politics at the grass-roots level, and not as a contributor of vicuna coats either. It faces the fact that clean politics must begin at home—with local committeemen, local candidates, local delegates. This approach is realistic; it emphasizes the fact that the way to clean up politics and pressure groups is to clean the rats out of the cellar first.

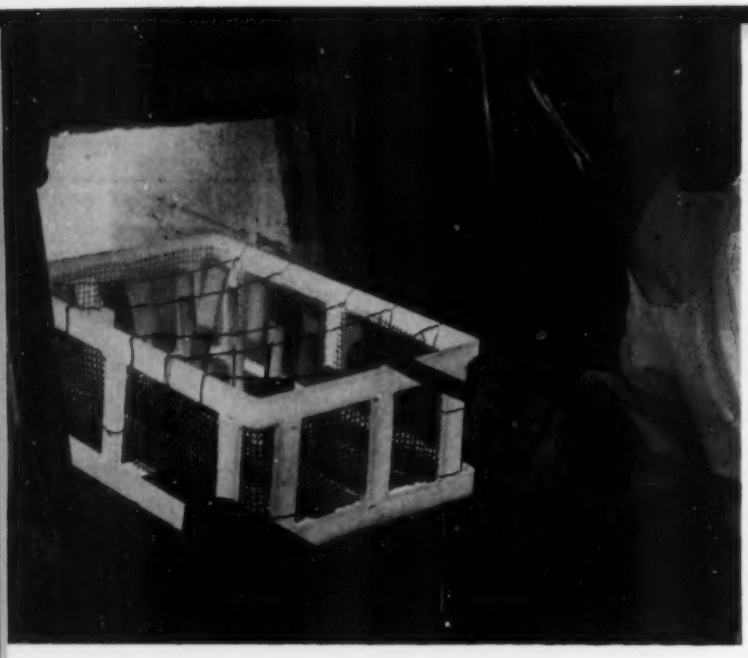
In a taped message, part of the do-it-yourself kit that Syracuse offers, Richard Nixon says, "Politics isn't a dirty word. It should be the part-time job of every American." The kit includes slide films, a political primer, four tape recordings, student's and leader's manuals, resource and study materials, as well as a 5-step plan. Any group can get it for a small amount by addressing the Manufacturers' Assn of Syracuse, PR Dept, 351 South Warren St, Syracuse 2, NY.

There's also a new book about the whole thing—a handbook at least as important to you as any engineering handbook—"The Businessman's Guide to Practical Politics", by J. J. Wuerthner, Jr (Henry Regnery Co, Chicago —$3.75). It is recommended by both political parties, is based on the Syracuse work.

I suppose we shall always have dishonest officeholders, grafters and cheats in government. Democracy gives the individual the freedom to become a crook if he wants to, and public office offers temptations. But it also gives other citizens the right to make sure the crookedness is restricted to individuals—who can be locked up—and doesn't become so general there is no recourse for honest people. It is just as crooked to misrepresent the majority of voters as it is to pick their pockets. And misrepresentation can be unknowing, because it is usually a minority that makes the noise.

So—you aren't limited to your own vote. You can multiply your voting power by bringing to bear your analytical knowledge and prestige as an engineer. You can learn politics just as you learn anything else. You can join with other honest and competent men to throw the grafters, leeches and incompetents out—by cleaning up your party at the local level. And you can also make sure your representatives in government are representing you by being on the inside, rather than the outside, of politics, by taking the do-it-yourself approach "of the people by the people and for the people."





to check the "super" in superalloys . . .

THIS TEST for OXIDATION RESISTANCE

New techinque peers under the surface oxide for clues to alloy performance at air temperatures up to 2200 F.

ROD SIMENZ, *research engineer*
Boeing Airplane Co, Seattle

An important byproduct of the work with space vehicles is a new approach for the comparison of superalloys. It is metallographic examination, which peers beneath the surface to understand and gage damage done by oxidation. Photomicrographs put the story on record.

The technique grew out of high-temperature problems. Although the nickel- and cobalt-base superalloys cannot stand high stress situations at much above 1800 F, rapid advances in space-vehicle design show they have great potential to 2200 F, if stresses are kept low. But at such temperatures, oxidation increases, and the problem has been—how much?

Most data on the oxidation resistance of these alloys has been based on weight-change tests, from which oxidation rates are calculated. But subsurface oxidation effects have been hard to evaluate. The advantage of metallographic examination is that it can also get below the surface—leading to a better understanding of oxidation damage.

The Method

It measures oxidation effects in a flat metal panel by photographing the cross-section after exposure at test time and temperature. This is a two-step procedure: (1) gage measurements are made with a micrometer eyepiece at 80X—five measurements are taken in the areas of greatest reduction, and averaged; (2) a similar examination but at 400X, evaluates subsurface defects like phase transformation, intergranular oxidation, alloy depletion, or phase changes.

The average depth of subsurface defect for one side is multiplied by two, then added to the gage loss to give the total affected depth. When this is plotted against exposure temperature for a given time, curves can quickly compare oxidation resistance of a number of alloys.

The photomicrographs on page 50 compare four superalloys given the same cyclic heating test at 2200 F. The panels were hung free to permit normal circulation of furnace air, and were air-cooled after each heating increment. This cyclic heating simulates normal on-off service common to many products, and it also evaluates spalling of the oxidized surface.

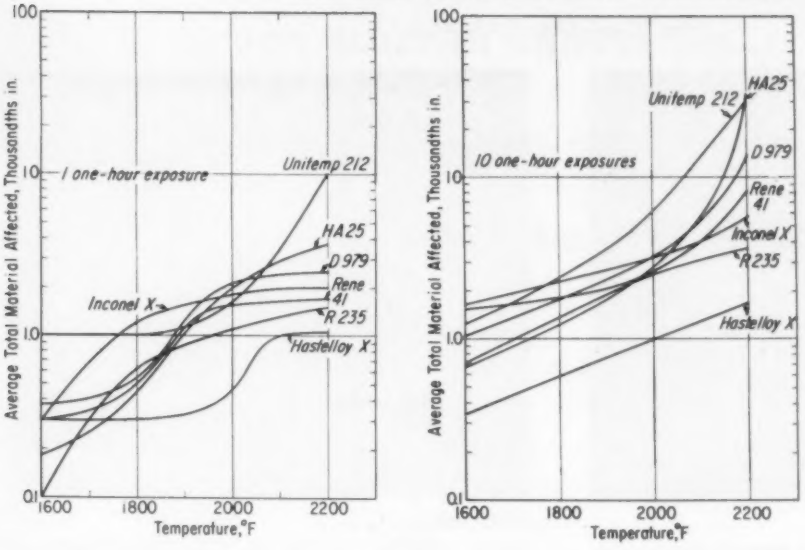
Biggest limitation with this method is the difficulty of making accurate quantitative measurements. As shown in the micrographs, the oxidation-affected zone for some alloys is sharply defined—making measurements easy. Others, however, respond to oxidation locally—so judgment must play a large part in the measurements.

Almost as important, this kind of data says nothing about the actual strength of the areas judged to be unsound because of oxidation. Furthermore, alloys vary in hot strength; an alloy with a high rate of oxidation attack as shown by this test may still retain sufficient strength, in the unaffected portions, to do the job.

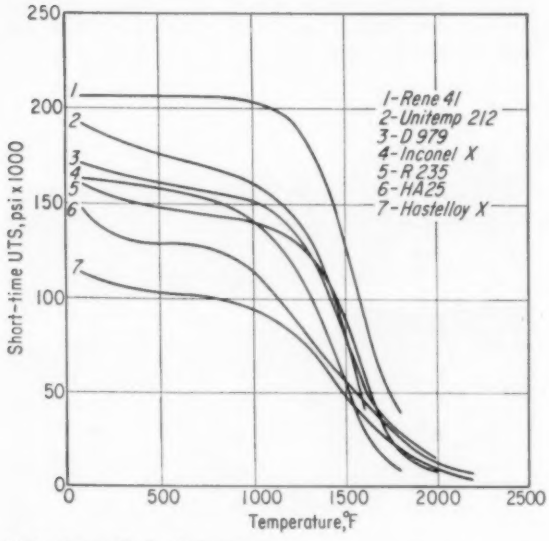
Applications for the Method

This metallographic examination will, however, give useful preliminary information and let the designer screen many materials at the outlet of a new problem. Nothing short of property tests—programmed at temper-

Seven Alloys Show Radically Different Behavior



Metallographic analysis . . reveals subsurface oxidation attack. Data show clearly that: when heating period is short, weight can be saved by using the higher strength alloys like Rene 41; for longer exposures, however, the effects of oxidation take over, and a lower strength, more oxidation-resistant material like Hastelloy X should be selected. These curves, based on simple oven tests in air, indicate only general trends. They do not reflect such other pertinent factors as corrosion contents in engine exhausts or erosive influence of fast-moving gases.



Hot strength is important . . . when judging oxidation performance of a superalloy. For example, 10-hr data at 1700 F shows Rene 41 has oxidized four times as much as Hastelloy X. Yet tensile strength data at that temperature favors Rene 41 by 2:1. Thus, depending on the application, the more oxidation-prone alloy may be best.

atures, air velocities and compositions anticipated—will give exact design data. But when this kind of information is still unavailable, metallography's report can provide a start.

Currently, the places in design where importance of oxidation resistance outweighs strength are limited. However, a shift is in the making—as design moves from short- and long-range missiles to advanced areas of boost-glide vehicles, orbital vehicles, satellites and space vehicles. Practical problems to be faced in the near future on this kind of hardware include: fuselage skins, afterburner structures, and guide-vane surfaces—all places where design must deal with oxidation stimulated by intermittent heating conditions. This oxidation has two adverse effects: It weakens the material; it leaves an inert oxide that cuts payload in space-vehicle applications.

Composition Tells a Story Too

The accompanying table of superalloys that were tested by metallographic technique gives clues to their relative oxidation performance. The column of alloying elements shows principal constituents in decreasing order of percentage present, from left to right. In general, the alloy's base has the most profound effect. Unitemp 212 makes its oxidation known because it has an iron base. Nickel alloys are better. Cobalt alloys which have excellent oxidation resistance at lower temperatures are

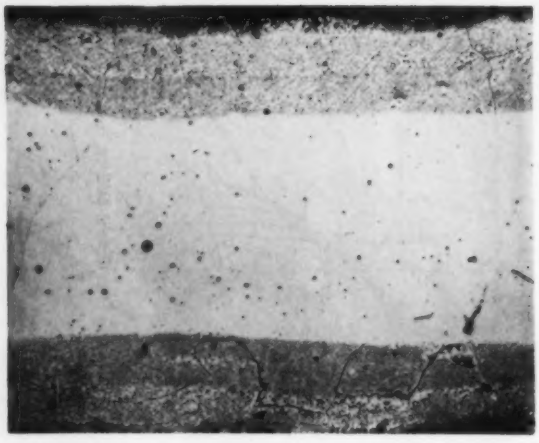
Composition Helps Explain Why the Alloys Oxidize

Alloy	Source	Alloy Base	Principal Alloying Elements	Rank at 2200 F (1-hr exposure)
Hastelloy X	Haynes Stellite	Nickel	Cr, Fe, Mo, Co, W	1
R235	Haynes Stellite	Nickel	Cr, Fe, Mo, Ti, Co, Al	2
Rene 41	General Electric	Nickel	Cr, Co, Mo, Fe, Ti, B	3
Inconel X	International Nickel	Nickel	Cr, Fe, Nb, Al	4
D979	Allegheny-Ludlum	Nickel	Fe, Cr, Mo, W, Ti, V	5
HA25	Haynes Stellite	Cobalt	Cr, W, Ni, Fe	6
Unitemp 212	Universal-Cyclops	Iron	Ni, Cr, Ti, Nb	7

Oxidation of 4 Superalloys at 2200 F

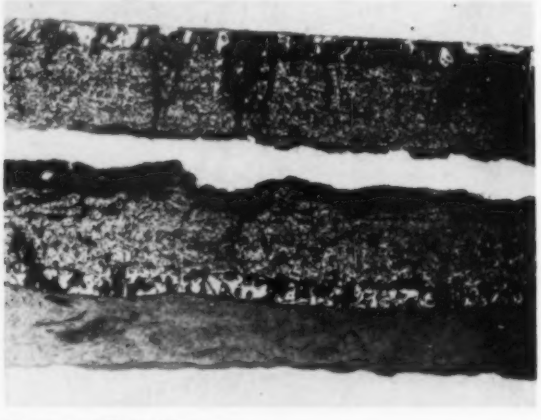
(after 10 exposures of 1 hr each)

Hastelloy X . . .
shows excellent resistance at this, and lower temperatures too. Visible here is extremely thin oxide layer at the edge. Etchant brings out some grain boundaries and carbide particles; neither indicates detrimental oxidation.



D-979 alloy . . .
reacts to oxidation in a clear and easily measured fashion, as shown by sharp demarcation between two oxidized layers, and relatively clear metal at center. Grain boundaries shown are from etchant, not oxidation.

Unitemp 212 . . .
takes a beating at this temperature, with edges showing severe oxidation and the attack penetrating deeply at some points—resulting local stresses would considerably reduce load-carrying capacity of this alloy.



Haynes alloy 25 . . .
has top temperature limit of about 2100 F under these oxidizing conditions (see 10-hr curves). Pushed another 100 F, the alloy oxidizes severely. Here, thin white band is the only sound metal remaining. Gray at bottom is plastic mounting material.

apt to have low-melting constituent at the grain boundaries so that incipient fusion as temperature rises can adversely affect oxidation: HA25 shows good performance to 2100 F, then oxidation accelerates.

Other alloying agents show up in a more complex manner. Their effect is somewhat dependent on the base alloy and the amounts in which they are added. For example: titanium when dissolved can enhance oxidation resistance, while as a precipitate it can increase intergranular oxidation. Less than 5% of Mo or V will have little effect in most alloys but when this amount is exceeded, oxidation rates can go up rapidly.

EDITOR'S NOTE: Other recent articles on corrosion problems:

"New Look in Porcelain Enamel," Nov 24 '58, p 53—latest color techniques for an old corrosion barrier.

"Corrosion Rate for Wrought Iron," Mid-Sep '58, p B5—gives charts for rates in air, salt water and acid.

"Stress Corrosion in Metals," Aug 4 '58, p 56—shows design steps to head off this delayed-action damage.

"Which Finish for Zinc Diecastings?" Mar 3 '58, p 52—presents chart guide to 10 methods for preventing corrosion.

"Hot-dipped Aluminum Coatings," Oct 28 '57, p 57—how design can give steel parts the corrosion resistance of aluminum.

"Stainless Steels for High Temperatures," Apr '57, p 135—mechanical properties of 8 corrosion-resistant alloys.

FOR BUILT-IN CONVEYORS—

NONMETALS
widen the choice

ANNESTA R GARDNER, *associate editor*

Design can now specify materials ranging from cotton through nylon to the latest synthetic and glass fabrics. Here's how the nonmetal belts are made, the advantages they offer, and how they are used.

When the product calls for designing-in a conveyor as part of the machine (and the trend is in that direction), the first thought is usually of metal. That's still the best material for conditions of high heat and heavy tension.

But technology today is offering an array of nonmetal belts, ranging in composition from cotton to the newest polyester fibers and plastics. These belts can be made light in weight and quiet in operation, nonmagnetic and corrosion resistant. They will conform to product shape, can provide product cushioning, and are often more resistant to abrasion than their metal counterparts.

How they're made

The major material of construction in almost all nonmetal conveyor belts is a fabric—canvas or duck—made of one or a combination of the fibers in the chart at left. Sometimes this fabric is used "as is." More often it forms the basis for the carcass (body), made by impregnating the fabric with oils, waxes or rubber. Frequently, several plies of fabric are laminated together, with the impregnant or "friction coat" serving as the binder. For many applications a cover, applied much like the tread of an automobile tire, is also desirable. For this purpose, rubber—natural or synthetic—is most often used.

Information on these materials, and the belts made from them, can be obtained from a number of sources. But assembling the data is not always simple. Traditionally, the belt manufacturers produce big belts in long lengths. These are sold to slitters and converters who, in turn, may sell to belt distributors. That puts the designer several steps away from the maker; and the lines of communication are not always too good. However, there are several auxiliary sources of information which can provide considerable help.

One of the best general references on conveyor types and characteristics, for instance, is a section of a booklet entitled simply "Fibers in Industry," published by the Textile Fibers Dept of DuPont. Another is "Conveyor Terms and Definitions," a 64-page booklet obtainable for $1 from the Conveyor Equipment Manufacturers Assn, One Thomas Circle, Washington 5, DC.

How the choice is made

Design factors that influence the choice of a particular material or construction in a nonmetal belt are listed on page 52. First, of course, it is important to know what is to be transported, over how great a distance, how fast, and to what destination. Second, there are such basic design factors as tension, impact, heat resistance, odor, color, flammability, and washability.

With nonmetal belts, as with the metal types, tensile strength and impact resistance are of minor importance. Alignment, too, poses few problems, unless the belt is a foot or more wide and at least twice as

CARCASS MATERIALS FOR CONVEYORS

FABRIC	natural	cotton	plain
		rayon	impregnated
		asbestos	asphalt, rubber, or resin
	synthetic fiber	nylon	
		polyester	
		glass	
PLASTIC	molded	slat	
		chain	
	film	supported	
		nonsupported	
		cord-reinforced	
	foam		
RUBBER	natural		
	synthetic	styrene-butadiene	cord-reinforced
		acrylic	
		neoprene	fabric-reinforced
		polyethylene rubber	
		fluorocarbon rubber	wire-reinforced
		silicone rubber	

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A CHECKLIST FOR DESIGN

To find the best nonmetal belt for any specific job, consider:

- What is to be moved?
- How much (per hour or day)?
- How fast (feet, or inches, per minute)?
- How heavy (loading—in lb/in. of width)?
- How hot?
- How corrosive?
- Has the product sharp edges that might cut the belt?
- Is it abrasive?
- Is any appreciable impact involved?
- Is noise—of the belt itself, or of the product striking the belt—a problem?
- Can the belt affect the conveyed product — through corrosion, abrasion, or pressure?
- Must the belt conform to shape of the product?
- Must slipping of the product be prevented?
- Is dusting or spilling a problem?
- Are their special qualifications: odor, color or rot resistance?

long (as in some farm and packaging machines). For short, wide belts it may be necessary to cock one roll out of plane, taper the drive and driven shafts, or install special guides to get the product to ride true. For that reason, a series of narrow belts, lined up with crowned pulleys, is often used instead of one wide one.

In nonmetal belts, though, heat resistance, cut resistance, elongation (both temporary and permanent), troughability, and fastener-holding ability are relatively more important than with metal belts–in selecting both the carcass and the cover.

When chemical resistance, color and washability are also specified, both cover and carcass must again be considered. It cannot safely be assumed, for instance, that the cover will protect the carcass completely from the chemical attack. In almost every belt there is some break–either at the sides or the splicing point–at which the carcass and its reinforcements are exposed.

As to color, almost all fibers are naturally white; but where white or light colors are wanted and washability is important, plastic film or covered belts are usually specified, because the unprotected fabric is too easily soiled. Even fabrics which are normally considered washable and stain resistant–nylon, for instance–may absorb oils and become difficult to keep clean.

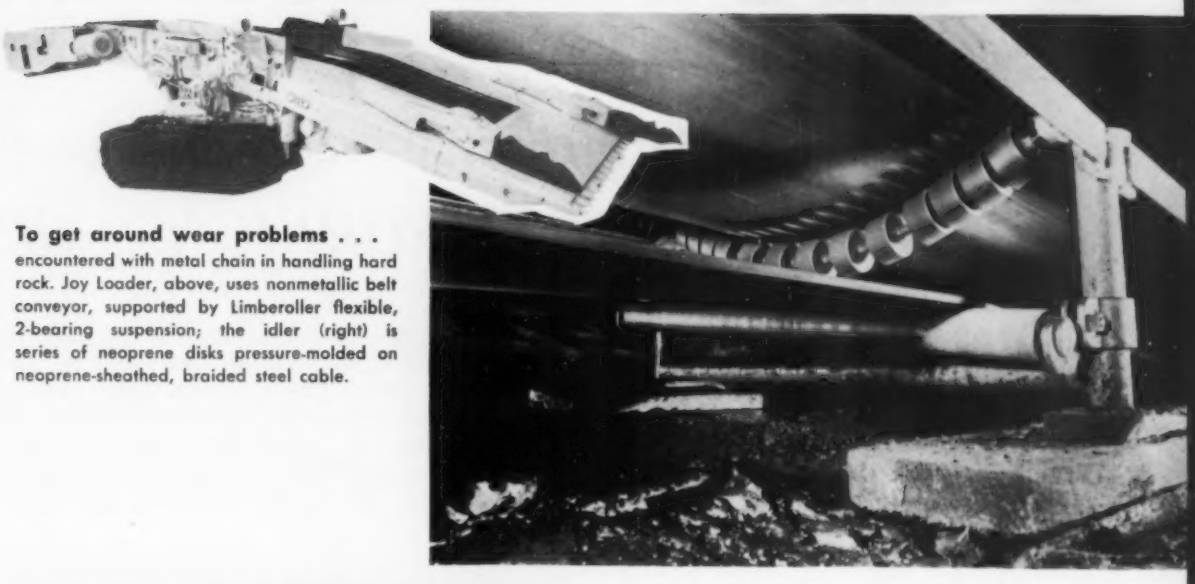
Belt-material selection guide

TO MEET THESE SPECIFIC NEEDS...	...consider these fibers and films (in each group, the more-serviceable materials are listed first)	...with these impregnants and cover casts
Where Max Service Temp (°F) Is:		
150	Cotton duck, cotton-nylon, rayon	Any
250	Nylon, polyester fiber or film, cotton-asbestos, cotton-glass, cotton-nylon, rayon	Neoprene, butyl, nitrile rubbers; oil, wax, or asphaltic resin; silicone, fluorocarbon rubber
350 to 450	Glass fabric	Fluorocarbon, silicone rubber
Above 450	Metal strip or mesh	
For Resistance to Attack by:		
Mineral and food acids in moderate concentrations	Glass, polyester, nylon, rayon	Most natural and synthetic rubbers; some oils and waxes
Alkalis	Nylon, glass, cotton, rayon	Neoprene, butyl, nitrile, chlorosulfonated polyethylene rubber; some waxes
Petroleum oils and greases	Glass, polyester, nylon, cotton	Neoprene, nitrile rubber
Vegetable oils	Glass, cotton, rayon, polyester, nylon	Chlorosulfonated polyethylene, nitrile rubber, butyl
Moisture	Glass, polyester, nylon, cotton	Natural rubber, neoprene, butyl; oils and waxes
Fire	Glass, polyester, nylon; rayon and cotton treated for fire resistance	Neoprene, nitrile, silicone, fluorocarbon rubber
Mildew	Any synthetic fiber; cotton and rayon chemically treated for mildew resistance	Any
For Special Qualities:		
Wear resistance	Spun nylon gives the highest Stoll abrasion resistance; cotton, the lowest; but impregnants and coatings improve performance of both	Nitrile rubber, chlorosulfonated polyethylene, special formulations of natural and SBR
Stretch resistance	Glass, rayon, cotton, polyester	.....
Tensile strength	Glass, nylon, polyester, rayon, cotton	.....

Other factors

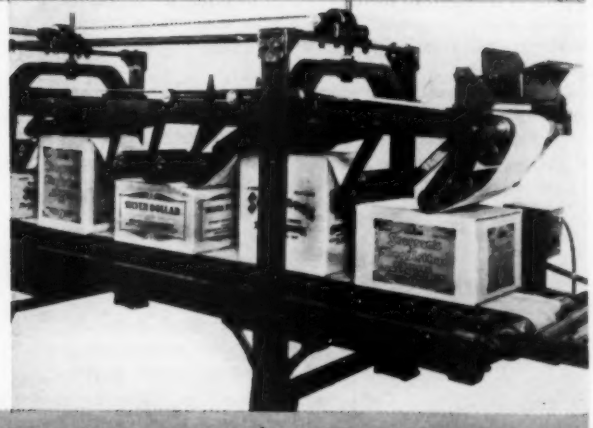
The way the belt is constructed may be equally as important as the material. In some applications, where moving the product is a problem, cleated or textured belt covers can help. Or, a dual-belt system may be needed if the product is too wide for a single belt.

A careful balancing of conveyor construction and design, though, can make it possible to meet the needs of almost any type of machine.



To get around wear problems . . .
encountered with metal chain in handling hard rock. Joy Loader, above, uses nonmetallic belt conveyor, supported by Limberoller flexible, 2-bearing suspension; the idler (right) is series of neoprene disks pressure-molded on neoprene-sheathed, braided steel cable.

To prevent backsliding . . .
on cotton-duck belts, International Harvester uses metal cleats on its harvester-thresher.



To apply pressure . . .
as well as to transport packages, Standard-Knapp case sealer adds a second soft, flexible canvas belt. It conforms to package shape and helps complete sealing.

FOR MORE INFORMATION ON CONVEYOR BELTS

Data on belt construction and performance is available, but often widely scattered. Suppliers of fibers, rubber and plastics . . . fabricators of big belts . . . and belt converters may all have to be tapped on a specific project. While the list below is representative, it is by no means a complete one:

Suppliers of basic materials and of large belts:

E I DuPont, Wilmington 98, Del
B F Goodrich, Akron, Ohio
Goodyear Tire & Rubber Co., Akron 16, Ohio
Owens-Corning Fiberglas Corp., 717 Fifth Ave, New York 22
US Rubber Co, 1230 Ave of Americas, New York 20

Suppliers and distributors of belts in smaller sizes:

Arthur S Brown Co, Tilton, NH
Gates Rubber Co, 999 S Broadway, Denver 17
Graton & Knight Co, Inc, 356 Franklin St., Worcester 4, Mass
Hewitt-Robbins, 240 Kensington Ave, Buffalo 5
Joy Mfg Co, Oliver Building, Pittsburgh 22
H K Porter Co, Philadelphia
Republic Rubber Div, Lee Tire & Rubber Co, Youngstown, Ohio
J E Rhoads & Sons, 2100 W 11th St, Wilmington 99, Del
Russell Mfg Co, Middletown, Conn
Ton-Tex Corp, 31 Columbus Ave, Englewood, NJ
Wickwire Spencer Steel Div, Colorado Fuel & Iron Co, Palmer, Mass

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DESIGN FEATURES

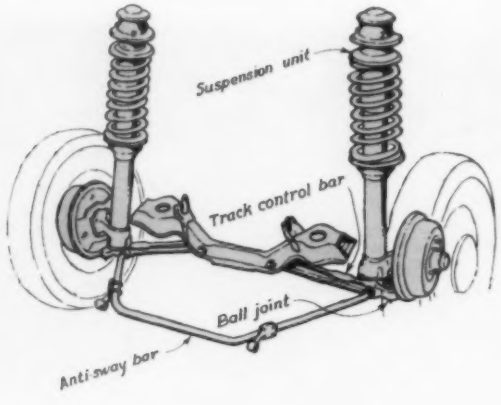
Originality—Design Secret of FOREIGN CARS

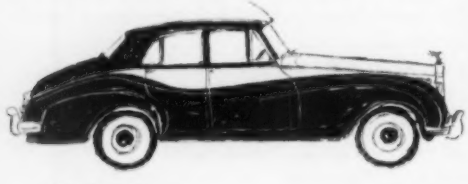
They're not all small. And Rolls-Royce shows they're not all sporty. But they do have this in common—mechanically, each shines with its own fresh approach to design problems. On this, and following pages, we have stripped down seven of the imports displayed recently at New York's International Auto Show—to reveal some of the ingenuity under their enveloping bodies. The show gave visitors a wide choice—over 600 cars exhibited by 68 manufacturers from 8 countries; prices ranging from under $1000 to $22,000; sizes from 2 passenger miniatures to largest of chauffeur-driven town cars.

English Anglia
German Taunus

Both are Ford products . . .
and both combine shock absorber, spring-mounting king-pin and suspension tube in one unit for a simple, efficient front suspension. (Shown here is Anglia.)

Besides its normal function the anti-sway bar also locates outer end of the track control arm. A single ball joint mounted on the track control rod provides necessary flexibility for spring travel while the steering movement is accommodated by swiveling the entire suspension tube. Anglia is produced by Ford Motor Co Ltd, Degenham, Eng; Taunus, by Ford-Werke A. G., Koln, W Germ.



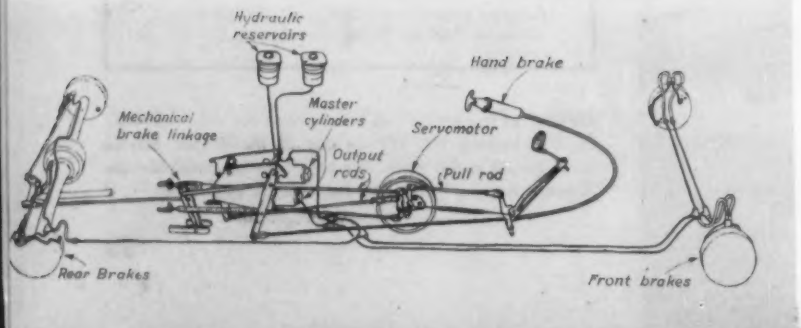


Rolls-Royce

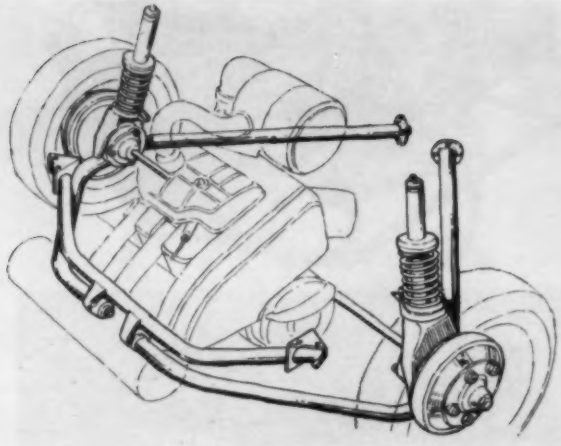
No other car . . .
in production today is talked about more and understood less. Its legendary braking system, for example, is a complex assembly designed to provide braking under all conditions and any possible emergency. But the basic elements are simple:

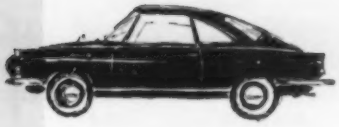
Initial movement of the brake pedal brings the rear brake shoes in contact with the brake drums. At that point the mechanical servomotor operates two hydraulic cylinders through the output rods and assists the application of the mechanical brakes. One cylinder operates the upper shoe in each front brake and the rear brakes as well; the other cylinder operates only the lower shoe in each front brake.

The servomotor is mounted on the right-hand side of the gearbox and is driven at one-fifth the propeller shaft speed. This servo operates whenever the car is in motion and provides positive power braking without an outside power source.



IN NEW PRODUCTS

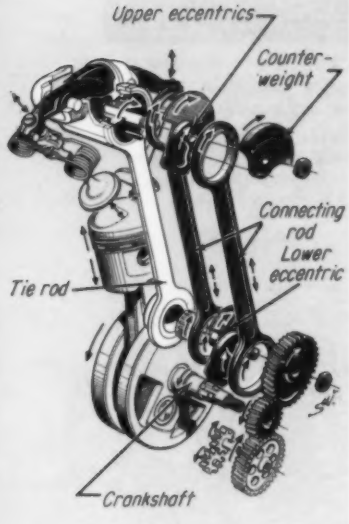


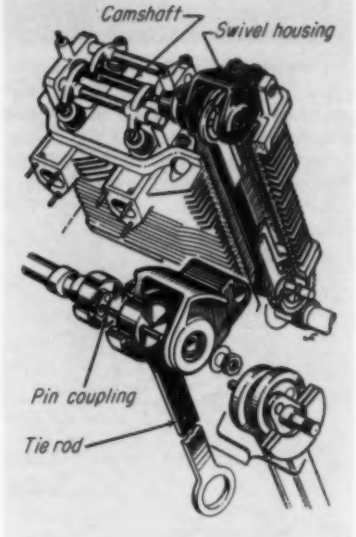


NSU-Sport Prinz

With rear engine . . .
and rear-wheel drive, space usually occupied by suspension is taken by engine and its accessories. Clean solution to problem is single tubular member on each side that transmits all braking and driving forces to the chassis. Half-shafts with universal joints drive the rear wheels and permit independent vertical movement for rough road surfaces. Rubber bushings at attachment points absorb vibration and eliminate lubrication points.

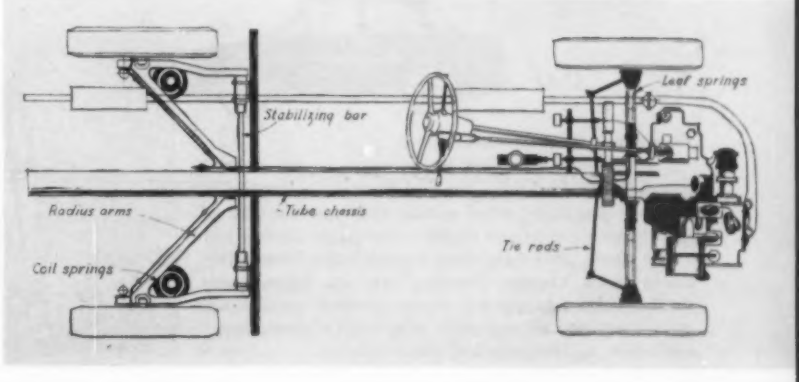
Overhead camshaft used on high-speed 2-cyl engine is driven by dual eccentrics connected by lightweight connecting rods. Twin connecting rods provide smooth drive action and avoid dead spots at top and bottom of stroke. A swivel housing in the cylinder head maintains fixed distance between upper and lower eccentric driveshafts, and a steel tie-rod connects the swivel housing and lower eccentric shaft—this prevents binding of the eccentric-drive connecting rods when cylinders expand. A simple pin-drive coupling between camshaft and upper eccentric drive allows vertical movement of the swivel housing during engine expansion. Aircooled twin cylinder has 583-cc displacement, develops 36 hp at 5750 rpm. Produced by NSU Werke Aktiengesellschaft, Neckarsulm, W Germ.

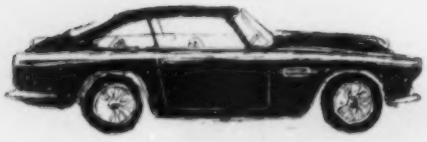




Lloyd Alexander TS

The backbone . . .
of this front-engine, front-wheel-drive car is a single large-dia tube. To it are attached the engine, front and rear suspension and all controls. Front suspension has two semi-elliptic leaf springs, one above the other, plus an auxiliary anti-roll spring. This arrangement eliminates need for auxiliary arms or rods to properly locate the wheels and provides a low unsprung weight. Rear suspension consists of welded box-section trailing arms and coil springs interconnected by a transverse stabilizing bar. Produced by Lloyd Motoren Werke G·M·B·H, Bremen, W Germ.



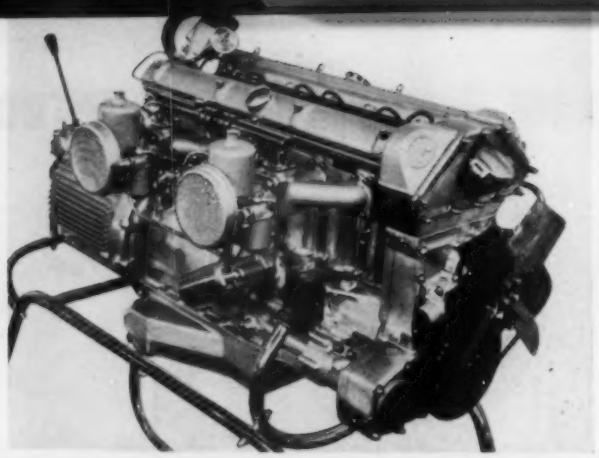


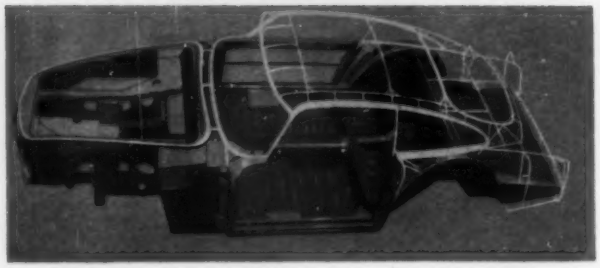
Aston-Martin DB4

This sports sedan . . .
boasts advantages of sedan and sports car—comfort and finish of the former; power and ability of the latter.

The car can accelerate to 100 mph and come to a full stop in less than 30 sec, using disk brakes. Top speed: well over 140 mph. The 3.7-liter 6-cyl aluminum alloy engine develops 263 hp at 5500 rpm, has specific weight of 2 lb per hp without gearcase. Specific weight of entire car is 11 lb/hp (standard British sedans are about 40 lb/hp).

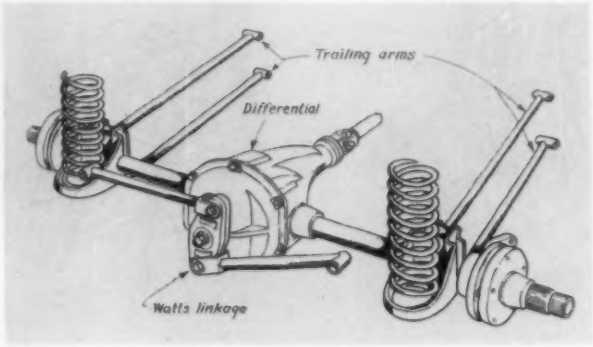
Engine wear is minimized with watercooled cylinder liners of centrifugally cast steel. Twin overhead camshafts and dual carburetors are used. A cross-flow radiator with side header tanks enables hood to be lowered and improves visibility. Produced by Aston-Martin Lagonda Ltd, Hanworth Park, Feltham, Middlesex, Eng.





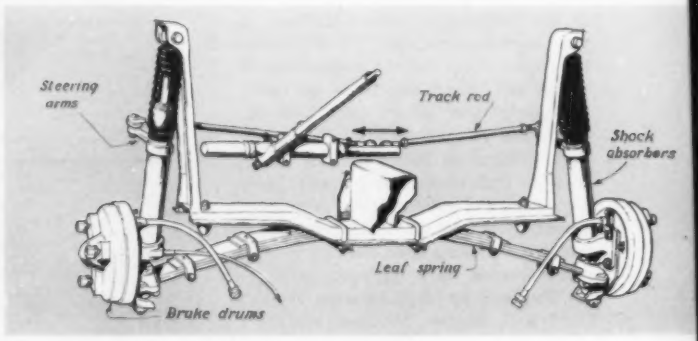
Unorthodox body structure . . .
has spot-welded platform chassis with shallow box-section sills that provide torsional stiffness and resistance to bending. Center driveshaft tunnel forks at front into engine bearers. Lightweight tubular superstructure welded to the platform makes only minor structural contribution. Aluminum skin cladding is fastened by graphited clips.

Suspension . . .
consists of solid rear axle and transverse wishbones at the front; coil springs and hydraulic shock absorbers all around. Rear axle is positioned longitudinally by double trailing arms, and laterally by a Watts linkage that accommodates axle deflections without lateral displacement. The trailing arms transmit thrust and braking forces, and prevent axle windup. Front suspension uses ball joints at outboard ends of wishbones. The wishbone arrangement permits placing rack-and-pinion steering elements ahead of the suspension crossmember and allows engine to be moved slightly further forward. An ideal 50-50 weight distribution is achieved with both front seats occupied and the 20-gal. gas tank half-full.



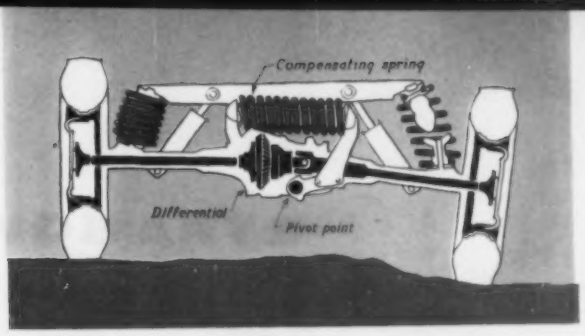
DAF

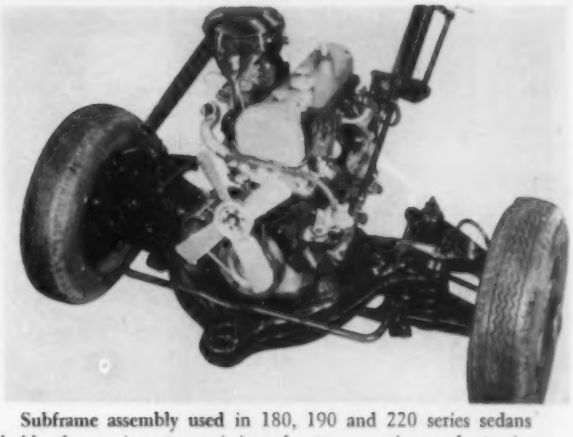
Front-wheel suspension . . .
has a low-slung transverse leafspring connected to steel crossmember. Leafspring has dual function of supporting load and positioning wheel spindle. Ball joints at ends of spring provide required flexibility for both steering and spring travel. Shock absorbers mounted above the spring also serve as kingpins. Steering arms are integral with shock-absorber housings and are connected by a split track rod. Simplicity of system is achieved by dual-purpose application of leafspring and shock absorber.



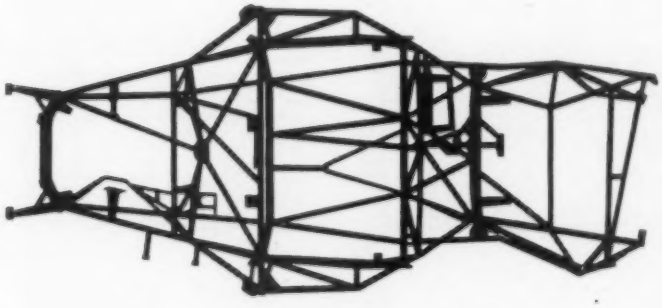
Mercedes-Benz

Independent suspension . . .
of rear wheels results from using a single-joint rear axle with low pivot point. Single universal joint and splined shaft above rear axle pivot point replaces four such units usually needed for independent rear suspension. Springing is achieved by coils and rubber helpers at each end of swing axle and the compensating coil that tends to reduce rear-wheel camber. Rubber-bushed connections at front of pivot point permit differential to rise and fall while thrust arms at outboard end of axle transmit acceleration and braking loads to chassis.

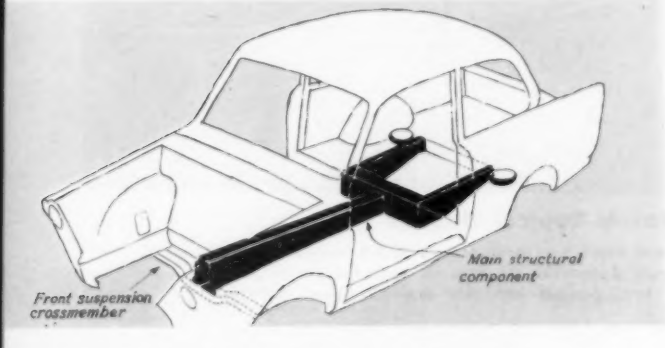




Subframe assembly used in 180, 190 and 220 series sedans holds the engine, transmission, front suspension and steering—and is rubber-mounted at three places to the main chassis. This permits the entire subframe to be removed for service, isolates engine vibration and front wheel shocks from the chassis. Produced by Daimler-Benz Aktiengesellschaft, Stuttgart-Unterturkheim, W Ger.

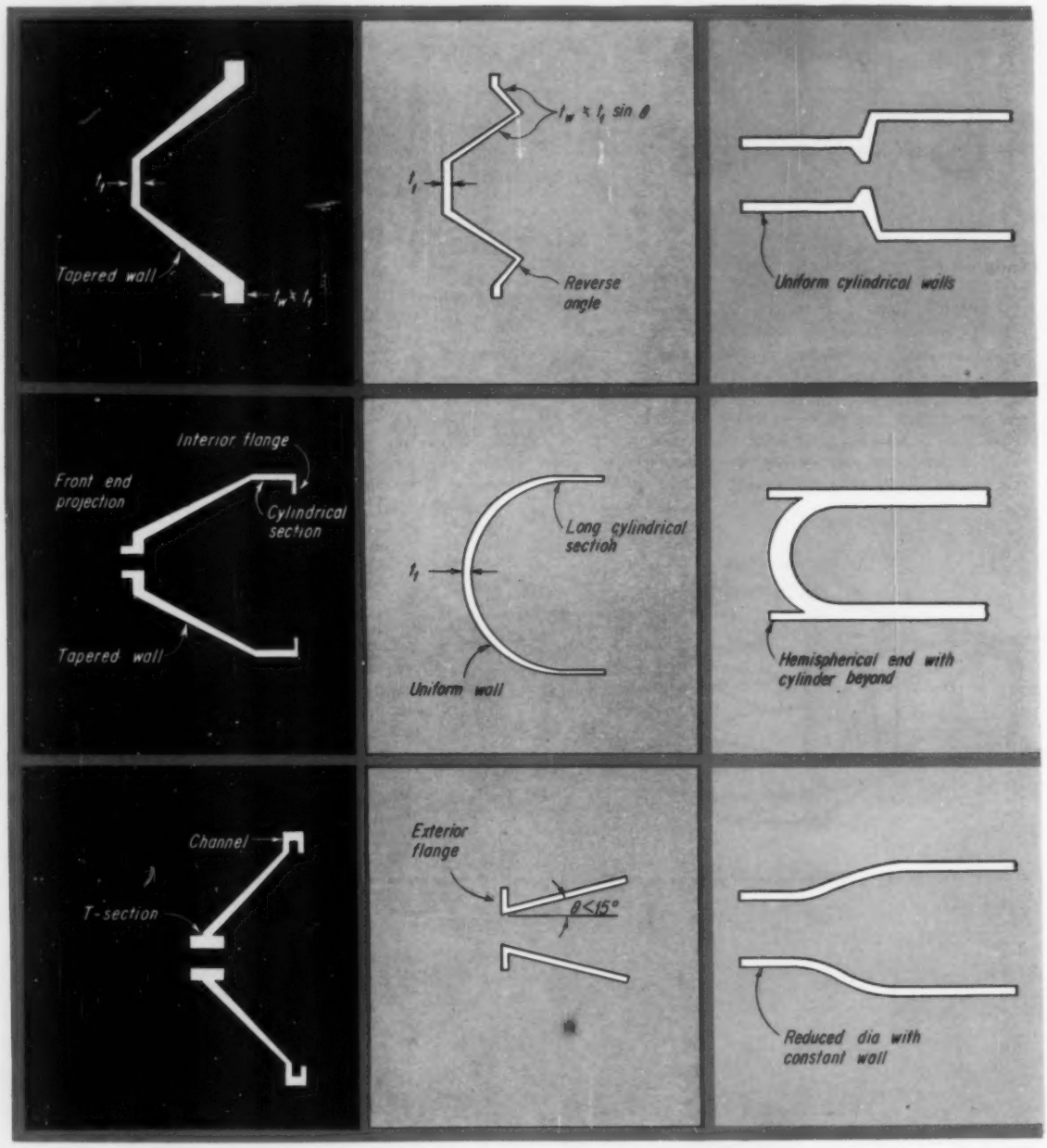


Chassis of 300SL roadster is probably most complex ever produced for a standard production auto. Maze of welded steel tubing follows aircraft practice to achieve maximum rigidity with minimum weight. Lattice-type frame envelopes mechanical components mounted in it. Assymetrical rear portion is required to accommodate oversize gas tank (26 gal.). Low profile is achieved by tilting 240-hp fuel-injection engine to within 40° from horizontal.



Utilized steel body uses box-section tuning fork shape as main structural component. Front end of tuning fork rests on transverse leafspring and rear is supported by two circular pans which hold coil-springs of rear suspension. Belt-driven automatic transmission fits between the fork at rear. Produced by Van Doorne's Automobielfabrik N. V. Eindhoven, Holland.

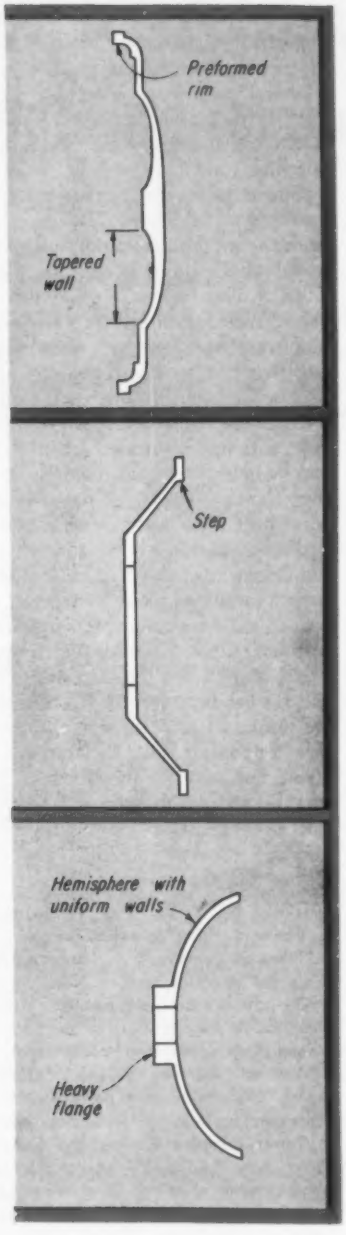
HOW TO PUT MORE



Power Spinning Plus Preforming—a Dozen Typical Shapes

The extra step allows incorporating added features in finished parts; composite shapes like the ones on these two pages would be impossible with only one-step power spinning.

INTO YOUR SPUN PARTS



Power shear spinning is today's high-production counterpart to manual spinning, but requires different concepts for best design. Here's how your thinking can start with basic shapes and progress to the more complicated ones.

F J COVELLI, *production engineer*
Commercial Shearing & Stamping Co, Youngstown, Ohio

Prodded by the needs of modern technology, spinning has been going modern. Originally it was just the wrapping of flat stock over a conical mandrel. Then came compression roll-forming, also called shear spinning or rotoforming. And now, with powered rolls that cold-flow the metal, the output is no longer limited to the older shapes. The door has been opened to tubular and cylindrical shapes, varying cross-sections, heavier parts, consistently better tolerances. Power spinning also works the materials to uniformly high tensile properties and gives fast production rates without skilled labor.

The cold-flow feature not only allows, but forces design to work with new shapes. When they are complicated, power spinning may require a preforming step—drawing, forging or welding. This will have advantages when the resulting one-piece construction eliminates further fabricating steps. However, preforming adds to costs, and can often be avoided by a better visualization of how power spinning affects design. How far can you go—with and without preforms—to get the most out of each procedure?

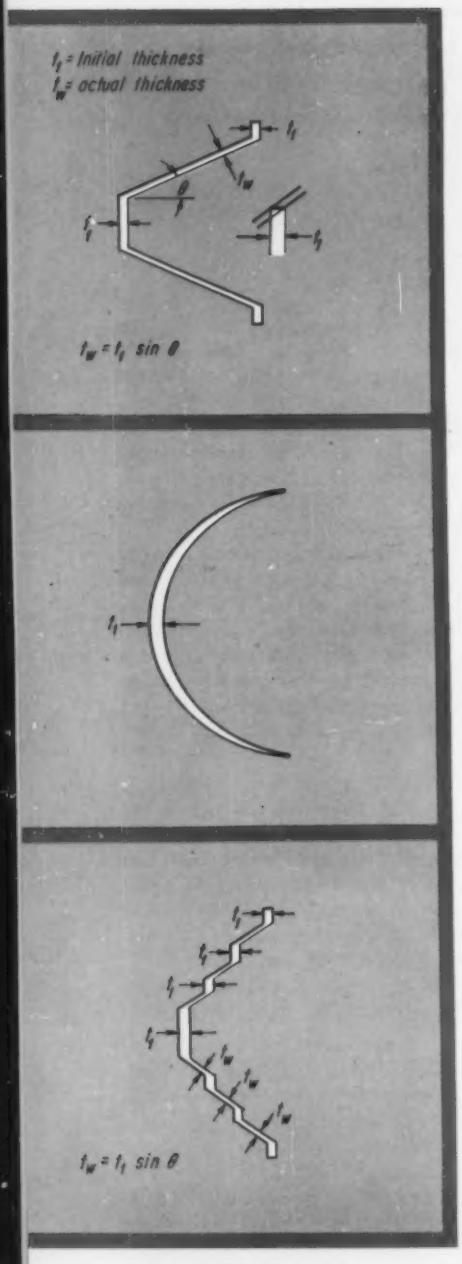
The Ground Rules

With manual spinning, wall thickness is basically uniform and the same as before forming. With power spinning, on the other hand, wall thickness varies with the angle of spinning. The thickness can be changed from the original and can be varied throughout the part—but within this limit: the horizontal component of wall thickness is not changed. Metal at a given diameter on the blank will still maintain its diameter on the formed part. Cold-flowing can improve thickness tolerance up to one-half that of the original, and final surface finish can be as fine as one-half the microin. finish of the rough blank.

Wall thickness on the finished part is not an independent variable. It is related to the shape of the original blank. In power spinning, original thickness shows up as the horizontal component of the wall measured perpendicular to the surface. Where the finished part has a flange or other vertical surface, the thickness will be equal to that of the blank.

Perpendicular thickness can be reduced a maximum of 70-75% with one pass. This means that the enclosed angle of a conical shape made from a flat blank cannot be less than 30° for a single pass; and for conical or hemispherical shapes, cannot have a depth less than about one-quarter the blank diameter.

Wall thickness can also be changed somewhat at either end of a part by special manipulation of the spinning tool. The ends can be flanged or beaded; the OD can be increased, or ID increased, or both. When OD is increased there is some lifting of the part from the mandrel,



Power Spinning—3 Basic Shapes

The proportions can be changed—but only with additional spinning passes or by starting with preformed blanks.

thus increasing ID slightly. This gives increased out-of-roundness, which may be a problem for mating parts.

Tolerance on thickness of the part is half that on the original blank. If the spun part specifies ±0.002, then it can be made from stock with a thickness tolerance of ±0.004 in. In some cases this means cold-rolled thickness tolerances can be obtained by power spinning hot-rolled stock.

Diameters—although dimensional tolerance can be improved, diameters remain basically the same in both blank and finished part. But since the mandrel which forms the ID is accurately machined and polished, thickness tolerance is improved, and diameters now become more accurate and concentric to each other.

Shape—small ends of conical shapes may be closed, partly closed or open. Large ends, which must always be open, can be given an interior flange or bead. This can be formed by a special motion of the tool without removing the part from the mandrel, so need not be considered an extra step.

Surface finish—although power spinning can produce surface finishes as fine as 6-8 microin. in multiple passes, a normal surface for one pass is approximately one-half the original surface finish. For example, if you start with a 125-microin. sheet then you can count on 64 microin. on the OD and an even better ID—all this without added finishing steps like grinding or polishing. Finishes on the ID are controlled by the surface finish of the mandrel, therefore better finishes can usually be obtained by giving a special polish to the mandrel. This naturally adds to cost of the part.

For the best finish this process can offer, the blank ID should be prefinished. Usually a blank is not finished to obtain a better final surface but to improve dimensional accuracy. This also improves the final surface. Complicated parts that require more than one pass on the machine also benefit correspondingly from the additional passes. Power spinning has another advantage—if a better finish is needed without further change in shape, then the part can be polished on the same mandrel without changing machines or setup.

Materials that give best surface finishes are the strong dense materials such as titanium, stainless steel, and 4130 which are normally difficult to cold work or machine.

Tubular Parts

Power spinning will produce tubes either from commercial tubing or from rolled and welded plate preforms. But design limits here are not quite like those for conical parts. There is no enclosed angle, so horizontal flowing of the metal is less limited. Multiple passes are done on the same mandrel, with large reductions possible before annealing is required. Therefore, multiple passes add only to machine time.

Single passes for ferrous materials can reduce thickness 30 to 40%, with the maximum for multiple passes about 80-85% (for nonferrous, about 50%). This means a tube can be made five times longer and the extra-thin-wall large-diameter precision tubing that results is an especially valuable application of power spinning.

Tolerances for a typical 6-in.-dia tube with a wall thickness of 0.100 in. can be held to within ±0.004 in. with less than ±0.008 in. out-of-round. Straightness for a 6-ft length is normally within 0.030 in. if made from a hot-drawn tube, or 0.010 in. if started from a machined blank. Standard ID finish is 64 microin., starting with seamless tube; 32 microin., from a bored blank; and 20 microin. when the ID has been honed. OD finishes are similar to conical parts, with each pass smoothing out the surface to about one-half the roughness of the previous step. Here special techniques can give maximum surface finish as fine as 4 microin.

EDITOR'S NOTE: For latest developments in powered shear spinning see:

"Powered Spinning . . . Important Development in Metal Forming," Jan 5 '59, p 43—how hydraulic controls with built-in "feel" allow heavier parts without losing the intricacy of manual manipulation.

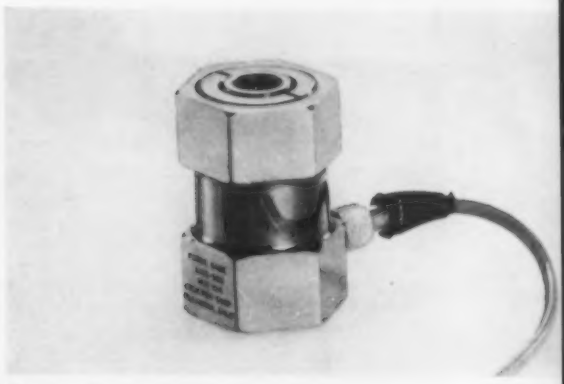
"Automatic Spinning for Conical Shapes," Jan 5 '59, p 46—how powered rollers shear-spin preforms into finished cones.

"Power Spinning Conical and Tubular Parts," Aug '56, p 135—earlier developments in power spinning. Gives advantages and limitations over other metalworking processes and design data on tolerances, properties, finishes and costs.

"Spinning vs Drawing," Mid-Oct '53, p D35—comparison of costs and shape as factors in choosing a forming process for circular cross-section sheetmetal shapes.

PIEZOELECTRIC TRANSDUCERS

measure fluctuating



→ *forces* . . . This gage reads loads from 5 gm to 5000 lb through frequencies from 2 to 6000 cps—in actuators, shock absorbers, motor mounts, etc. (Endevco Corp)

Put pressure on these crystals and they generate an electrical charge—no need for external power supplies or fancy bridge circuits. But though they seem simple, they have unusual properties you should know about before putting them to work.

J J SIEGEL
Research and Advanced Development Div
Avco Manufacturing Co

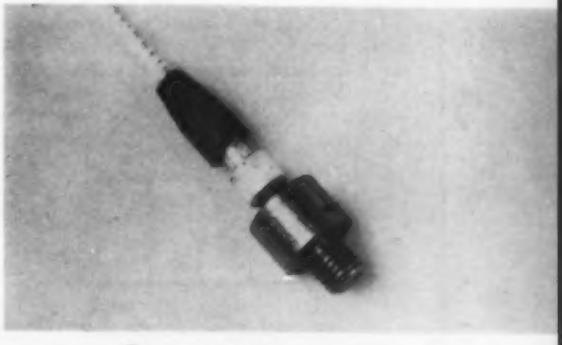
→ *pressures* . . . Probe responds to transient shock pressures without disturbing flow pattern; has open-circuit sensitivity of 0.2 v/psi for pressures to 500 psi. (Atlantic Research Corp)

Why the growing popularity of piezoelectric transducers? In doing their work—the conversion of mechanical to electrical energy, or vice versa—they take little space and are lightweight, rugged, reliable, easily calibrated. They are not too costly at the outset, and are cheap to repair (because it is usually only the piezoelectric crystal itself that need be replaced). In comparison with other transducers, they offer larger outputs than other self-generating types, and respond to higher frequencies than the types using diaphragm, bellows or bourdon pressure cells (for a guide to such static-pressure transducers see *PE—Jan 5, p 48*).

The advantages must, of course, be considered in terms of limitations. Piezoelectric crystals are sensitive to vibration and nearby electric and magnetic fields. Temperature changes can also give trouble—even a very small change may disturb previously established calibration curves.

Because the crystal element will generate an electric field in response to any mechanical force, the range of piezoelectric applications is nearly as broad as the number of situations requiring that a force be sensed or developed. A well-known application is the phonograph cartridge (but for the exacting demands of the hi-fi enthusiast, the crystal cartridges have been losing ground to magnetic transducers—these match recording characteristics better).

Piezoelectric materials also do many jobs in the oppo-



→ *accelerations* . . .

Accelerometer is sensitive to accelerations of 0.1 to 300 g, needs no temperature compensation or external cooling for temperatures from —100 to 525 F. (Gulton Industries Inc)

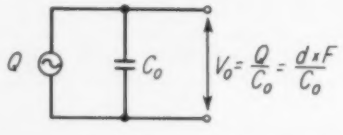
Characteristics of Typical Piezoelectric Transducers

	Frequency Range, cps	Output Voltage	Weight, oz	Operating Temp, °F	Scale Limits
ACCELEROMETER	1–20,000	0.5–50 mv/g	0.25–2	−65 to 500	0.03–15,000 g
PRESSURE GAGE	1–20,000	1–50 mv/psi	1–2	−65 to 500	0.5–2500 psi
FORCE GAGE	1–10,000	1–100 mv/lb	2–10	−65 to 500	0.5–5000 lb

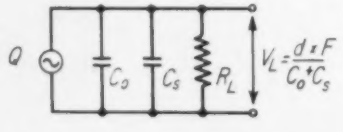
The Circuits Look Like This

Piezoelectric crystals are either natural materials (quartz or tourmaline) or synthetics—barium titanate, lead zirconate-titanate (PZT), Rochelle salts and others. All these materials generate a charge in the same manner: Compress the crystal and a charge is generated with a polarity which depends upon crystal orientation; elongate the crystal and a charge of opposite polarity is generated. Whatever the charge, it leaks off at a rate dependent upon the internal resistance of the crystal and the shunt resistance in the external circuit. The sum of these resistances can never be infinite; therefore, frequency response can never be reduced to indicate steady-state conditions.

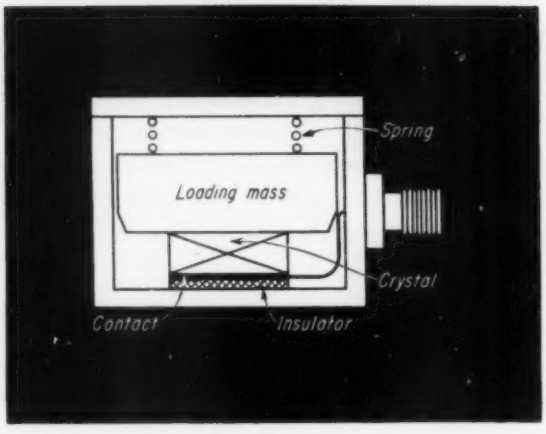
Looking at the crystal itself, its equivalent circuit consists of a generator which develops a charge Q proportional to deforming force F and shunt capacitor C_o. Output voltage V_o may be calculated from the charge coefficient of the crystal d and the electrostatic relationship.



This circuit, while adequate for dealing with the crystal without cable or load, does not represent the circuit conditions in a practical transducer application—where there will be additional capacitive and resistive loading, C_s and R_L, because of the output cables and the measuring instrument. For such conditions:



The additional capacitor attenuates output; the resistor causes charge leakage, destroying low-frequency response. It is best to keep the time-constant $R_L(C_o + C_s)$ of the circuit high by keeping R_L high rather than by increasing capacitance—which also reduces sensitivity.



How accelerometer works . . .

In this sketch of single-axis type, loading mass compresses piezoelectric crystal in response to acceleration. Spring preloads crystal, allowing transducer to measure both positive and negative accelerations.

site direction—converting electrical signals to mechanical energy. Dental drills, flaw detectors, thickness gages, and cleaning equipment are common applications in the field of ultrasonics.

For measurement and control where mechanical energy is converted to electrical signals, three types of piezoelectric transducers predominate: accelerometer, force gage and pressure gage. Their mode of operation is identical. The parameter being measured acts directly on the pressure-sensitive crystal, straining it and causing an electric field to be developed.

Frequency Limitations

A piezoelectric crystal is essentially a charge generator—not a voltage generator. This charge leaks off through a finite shunt resistance which is always present and limits low-frequency response. High-frequency response, on the other hand, is limited by the natural frequency of the transducer. Response will be linear when the variable being measured is proportional to crystal deformation. In accelerometers, for example, this is true when forcing frequency is less than about $\frac{1}{3}$ the natural frequency.

The limit on low-frequency response means piezoelectric transducers are practical only when measuring and controlling dynamic forces. This fact can be used to advantage when, for example, it is desirable to record transient forces but reject any steady-state forces on which the transients may be riding.

Load Must Match Transducer

For best low-frequency response, a cathode follower circuit is usually put between transducer and measuring circuits. This simple amplifier, with a gain of less than one, has a very high-impedance input which does not load down the transducer, and provides a low-impedance output which can be connected to almost any kind of recording or measuring instrument. In some cases, transducer output is fed directly to an oscilloscope or other measuring instrument with high-input impedance. This is particularly useful for studying high-frequency phenomena such as shock motions of mechanical structures or blast waves in shock tubes.

Because voltage output of the crystal is inversely proportional to the shunt capacitance, it is important that no shunt capacitance be unknowingly added to the external circuit. Manufacturers usually supply a length of coaxial cable which is matched to transducer and calibrations have been made with this cable. A different cable or a cable of different length will affect these calibrations When other cables are used, the calibration values should be altered according to electrostatic relationships. However, cables designed for use with the transducer are often chosen to compensate for temperature changes too. Such compensation is not always easy to reestablish with a new cable and it is better to return the transducer, new cable and load to the manufacturer for recalibration.

EDITOR'S NOTE: Two previous articles discuss and compare basic operating principles for transducers of various types. Already referred to above was "Static Pressure Transducers," Jan 5 '59, p 48. Besides describing such devices, it defines the common transducer terms. "Pressure Transducers," Jan '54, p 174, lists features and operational limits for magnetic, strain gage, capacitance and crystal transducers.

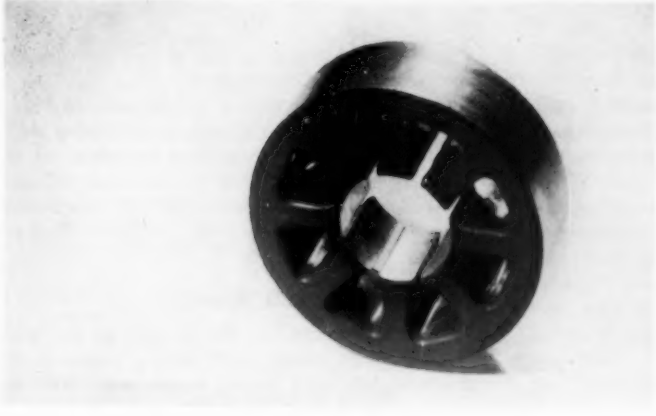
For more about the physics of piezoelectricity and characteristics of several common piezoelectric materials, see "Piezoelectric Ceramics," Oct '54, p 161. Pressure cells made from the rare earths are described in "New Pressure-sensitive Material," Sep 16 '57, p 106. And for a discussion of cavitation attack which damages piezoelectric materials when they convert electrical signals to mechanical energy, see "Cavitation Attack in Ultrasonics," Sep '55, 173.

"Ready-made Amplifiers for Transducer Signals," Sep '51, p 143, explains advantages and methods of using standard-temperature controller-recorders as transducer-signal amplifying and recording instruments.

ADHESIVES do a better job of bonding LAMINATION STACKS

RUSSELL E GEORGE
President
Gebe Electronic Services Inc
Los Angeles, Calif

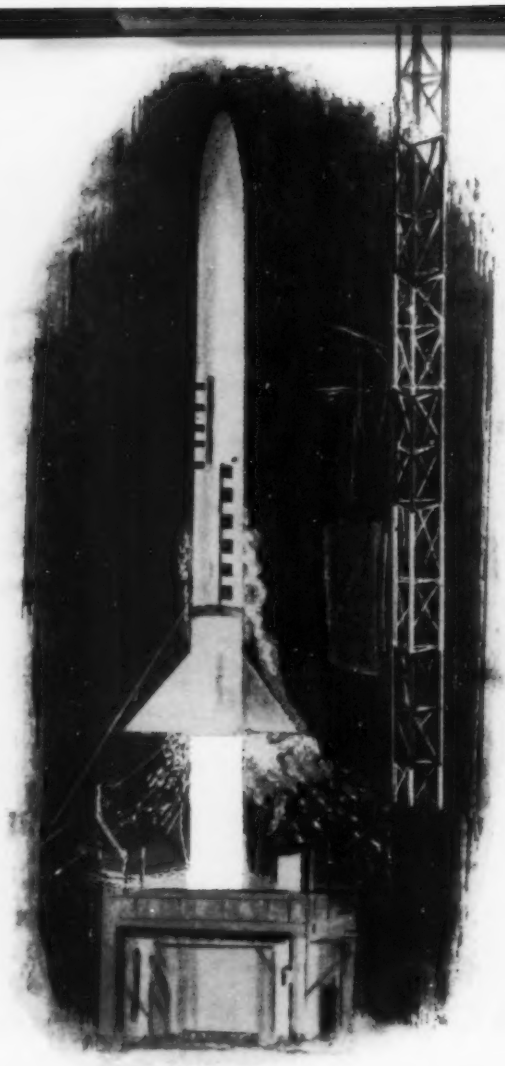
In a process that supplants rivets and welds, individual laminations are chemically cleaned, roller-coated with a phenolic thermosetting adhesive and then air-dried. After this, laminations are hand stacked, and the adhesive hot-cured under pressure.



Advantages are finished tolerances of 0.005 in. on stack height, and 10% more metal with better insulation between laminations. Vibration of laminations is prevented. By closing all gaps between laminations the process helps in more effectively applying epoxy slot insulation by the fluidized bed method (Jan '57, p 140; May 5 '58, p 6).

Drawbacks are higher cost since laminations must be cleaned, and roller-coating is a hand operation. Three coats are needed at times. Laminations must be oriented for stacking to keep the burrs in the same direction. Stacks are baked in spring-loaded fixtures, and excess adhesive is removed by an air blast of ground walnut shells. But the adhesive bonding delivers closer tolerances and lower electrical losses than obtainable by conventional methods.

The fluidized-bed epoxy coating for the winding slots is unaffected by temperatures up to 400 F, and withstands 500 volts per 0.001 in. The coating cost is low and the coating is easily machined, protects against corrosion and improves appearance. ■



A month ago, Dr. Ungar showed our readers how to apply tabular methods to static structures that resist analytical solution. Now, with two examples—vibrations of a mass-spring system, and flight of a rocket—he demonstrates that . . .

numerical integration

WORKS WITH DYNAMIC SYSTEMS TOO

ERIC E UNGAR
senior engineering scientist
Bolt Beranek and Newman Inc
Cambridge, Mass

Usefulness of tabular methods for evaluating integrals goes considerably beyond the cases explained in the March 16 issue. Those involved static, complex loading. Numerical integration is a simple, surprisingly accurate tool that can also be put to work analyzing the dynamics of mechanical systems.

With such systems it is common to run up against ordinary differential equations of the second order. These equations are troublemakers. Usually their solutions are known only for the few relatively simple cases where the equations turn out to be linear and have constant coefficients. The temptation then is either to make broad assumptions that will linearize the equations—which often makes the solution worthless from a practical viewpoint—or else to seek help from mathematicians and their computers.

Here is where numerical integration can step in. It is so easily applied to solving any ordinary differential equation that there is no need for advanced training. Fairly accurate results can be obtained without much work. Two examples—oscillations of a mass-spring system, and flight analysis of a rocket—illustrate this method.

How the Method Works

The method involves the division of the total time of the motion under study into a sequence of small intervals. Letting t denote a convenient time interval,

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and x_{n-1} and x_n denote positions of a point at beginning and end of the n^{th} time interval, the average velocity during the n^{th} time interval then is:

$$v_a = \frac{x_n - x_{n-1}}{t} \qquad (1)$$

so that the displacement at the end of the interval may be expressed in terms of displacement at the beginning:

$$x_n = x_{n-1} + tv_a \qquad (2)$$

Similarly, the accelerations and velocities are related by the equations:

$$a_a = \frac{v_n - v_{n-1}}{t}, \qquad v_n = v_{n-1} + ta_a \qquad (3)$$

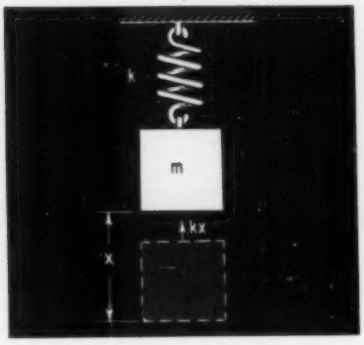
where a_a denotes the average acceleration during the n^{th} interval, and v_{n-1} and v_n denote the velocities at the beginning and at the end of this interval. Further, for the small time intervals assumed, the definition of "average" allows these equations to hold true:

$$v_a = \tfrac{1}{2}(v_{n-1} + v_n), \qquad a_a = \tfrac{1}{2}(a_{n-1} + a_n). \qquad (4)$$

These equations will now be applied in tabular form to analyze two problems in dynamics.

Example—Mass and Spring System

■ The simple dynamic system shown below consists of a 386-lb weight hanging from a spring with a spring constant of 9 lb/in. Problem is to calculate the time it takes the mass to return to its equilibrium position (during its first oscillation) if it is displaced 2 in. downward, and then released.



From a summation of forces, the equation of motion is

$$\left(\frac{W}{g}\right)\frac{d^2x}{dt^2} = -kx$$

or, with the constants of the problem at hand,

$$\frac{d^2x}{dt^2} = -9x$$

where x is displacement, in inches, and t is time, in seconds.

To use the numerical method, a small time interval is selected—say, $t = 0.1$ sec. If the average displacement during the first interval is known, the average acceleration can be found from the above equation. Since this motion is not known at the outset, some average acceleration is assumed. From this, calculate the average displacement and check it out in the differential equation with the assumed acceleration. If it checks, values are correct and may be used for the next step; otherwise, another assumption is made and the process repeated until it does check.

	n = 1			n = 2	
Steps	First Trial	Second Trial	Third Trial	First Trial	Second Trial
v_{n-1}	0(1)			− 1.76(3)	
x_{n-1}	2(1)			1.912(3)	
a_a (assumed)	−32	−17	−17.6	−17.0	−16.03
ta_a	− 3.2	− 1.7	− 1.76	− 1.7	− 1.6
$v_n = v_{n-1} + ta_a$	− 3.2	− 1.7	− 1.76	− 3.46	− 3.36
$v_a = \frac{1}{2}(v_{n-1} + v_n)$	− 1.6	− 0.85	− 0.88	− 2.61	− 2.56
tv_a	− 0.16	− 0.085	− 0.088	− 0.261	− 0.256
$x_n = x_{n-1} + tv_a$	1.84	1.915	1.912	1.651	1.646
$x_a = \frac{1}{2}(x_{n-1} + x_n)$	1.92	− 1.958	1.946	1.781	1.784
$a_a = -9x_a$	17.28(3)	17.6(3)	−17.6(4)	−16.03(3)	−16.06(4)

NOTES: (1) Values based on starting conditions of zero velocity and 2" displacement
(2) Disagrees with assumption, so use as next starting point
(3) From values for x_n and v_n of previous column
(4) Checks with assumed value, hence correct

Continuing in this manner, the following table of displacements and velocities is developed:

Time, sec	0	0.1	0.2	0.3	0.4	0.5	0.6
x, in.	2.00	1.91	1.66	1.26	0.74	0.17	−0.43
v, in./sec	0	−1.76	−3.36	−4.67	−5.57	−5.98	−5.86

By interpolation one may then find the time at which the displacement x is zero:

$$t = 0.5 + 0.1\left(\frac{0.17}{0.17 + 0.43}\right) = 0.528 \text{ sec.}$$

The exact solution for this illustrative problem is $x = 2\cos(3t)$, so that the time at which x first becomes zero is

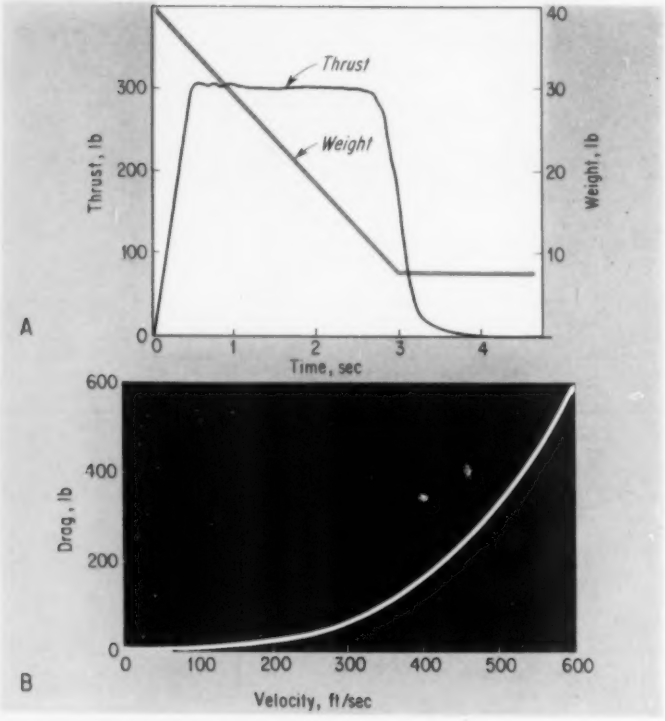
$$t = \frac{\pi/2}{3} = 0.523 \text{ sec,}$$

indicating that the error in the numerical solution is on the order of 1%.

There are some inherent difficulties with this method. Obviously, the method is not self-checking, and care must be taken at every stage of the calculation to avoid errors. Errors can accumulate, so that the result for successive intervals may deviate more and more from the true corresponding values. Hence, it is possible that the result obtained after a large number of time intervals will be considerably in error. On the other hand, the intervals must be sufficiently small compared with the total interval to be studied, so that changes of the variables during the total interval are not "smeared out" so much as to destroy the accuracy of the solution.

(CONTINUED ON NEXT PAGE)

Example—Rocket Flight



■ Analysis of the vertical flight of a rocket is a more complicated problem. Consider a small signal rocket weighing 40 lb, of which 30 lb is propellent. Wind-tunnel tests show that thrust T of the rocket varies with time (measured from the instant of ignition), and drag D of the rocket varies with velocity v as shown in the graphs (A) and (B). The propellant has been designed to burn with a very nearly constant mass rate of 10 lb/sec, so weight of the rocket is assumed to decrease linearly until the cutoff point, as shown in (A).

To determine setting of a timer for the ignition of a flare, the variation of altitude with time is to be computed for this rocket. (Variations of gravity and air density with altitude are neglected here for the sake of brevity, but these factors could be included without much difficulty.

The differential equation of the motion of the rocket under these assumptions may be found from a free-body analysis to be (parentheses indicate functions):

$$T(t) - D(v) - W(t) = \frac{W(t)}{g}\,\frac{d^2x}{dt^2}$$

where x denotes the altitude and g the acceleration of gravity. Because the drag D is a function of the velocity v, this equation cannot be integrated directly, and the trial-and-error integration process is necessary.

For any given time interval, the average thrust and drag are readily obtained from the given graphs, since they depend only on time. Drag is more difficult to determine. It is best to assume an average velocity for an interval, and obtain an average drag on this basis. Then compute an average acceleration, using this value of the drag. From this acceleration, once more calculate the average velocity.

If the correct average velocity was assumed, the assumed and the calculated values coincide. Thus, the process should be repeated with various assumed average velocities until this check is obtained; thereafter proceed to the next time interval. The method is shown in the following table, which uses time intervals of 0.4 sec.

Time interval number, n	1			2		
time count, sec	0			0.4		
v_{n-1}	0			23.8		
T_{avg} (from graph A)	110			295		
W_{avg} (from graph A)	38			34		
v_{avg} (assumed)	50	10.6	11.9	100	70	70.8
D_{avg} (from graph B)	10	2.1	2.3	18	13	13
$a_{avg}=g\left[\frac{T_{avg}-D_{avg}}{W_{avg}}-1\right]$	52.8	59.3	59.3	230	235	235
v_n (from Eq 3)	21.1	23.8	23.8	116.0	117.8	117.8
v_{avg} (from Eq 4)	10.6	11.9	11.9	69.9	70.8	70.8
x_{n-1}			0			4.8
x_n (from Eq 1)			4.8			33.2

Continuing in this manner establishes the following table showing the rocket altitude and velocity with time:

t, sec	0	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8
v, ft/sec	0	23.8	117	162	217	336	451	491	387	261	180	128	91.6
x, ft	0	4.8	33.2	98.2	182	296	453	642	818	947	1035	1097	1140

These results can be plotted as altitude vs time or velocity for purposes of interpolating values not listed in the table.

REPRINT of this article can be obtained for your reference file by checking No. E76 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 119.

Some Ideas

for your file of practical information on drafting and reproduction from

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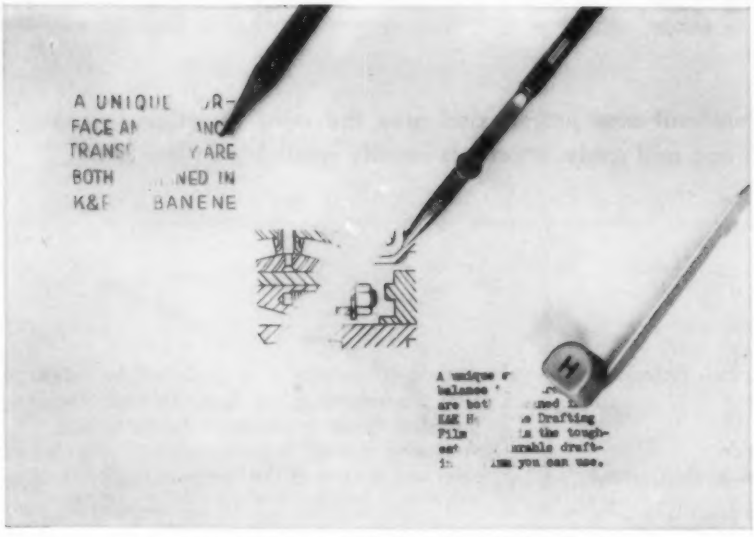

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. . . and its package

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12 WIRE GUIDES

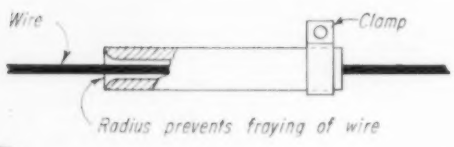
They will also protect and give the right direction to rope, thread and cable. Most are readily available at low cost.

FRANK WILLIAM WOOD JR, *engineer*
Vitro Laboratories, Silver Spring, Md

Methods of guiding wire depend on such factors as:

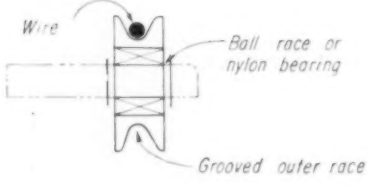
1. Distance to be guided.
2. Permissible drag or friction.
3. Direction of feed to and from guide.
4. Tension on the wire. If it can slacken, some method of retaining it on guide will be necessary.
5. How the wire-end is fed. If not through the guide, provision should be made for center feeding.

The following methods illustrate different controls that meet one or more of the foregoing requirements.



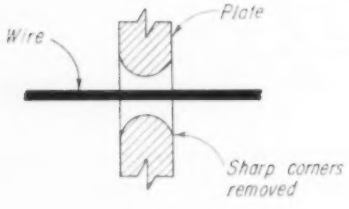
1

Tubular guide . . .
of either plastic or metal is ideal where wire must be guided and protected for a considerable length.



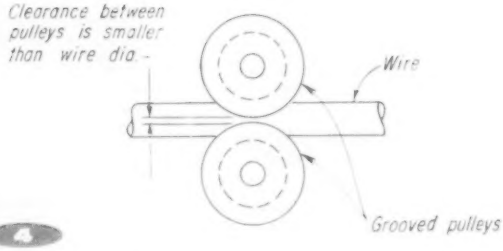
2

Special bearing . . .
to reduce wire drag can be either multifunction ball bearing with outer race grooved to accommodate and guide the wire, or plain grooved pulley slipped over a nylon bushing.



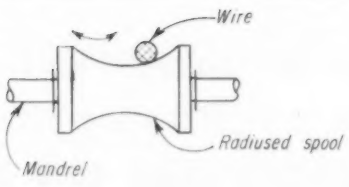
3

Hole in flat plate . . .
provides an effective, low-cost wire guide through bulkheads, container sides, etc. Hole-edges should be rounded off to prevent fraying.



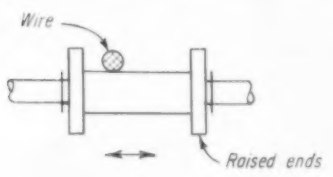
4

Matching pulleys . . .
prevent wire from leaving pulley when play results from kinks or whipping.



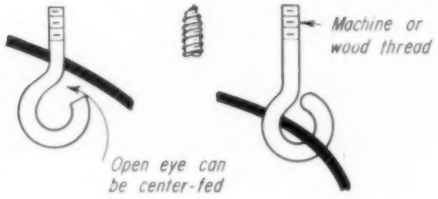
5

Capstan-type spool . . .
permits some lateral movement of wire, while it tends to keep wire at spool center.



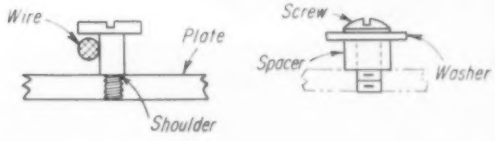
6

Straight spool . . .
allows lateral movement of wire. Raised stops are needed if this movement brings wire too near ends of the spool.



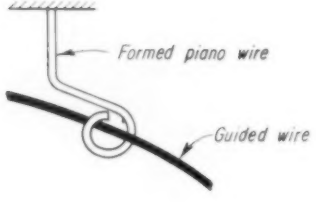
7

Eye bolt . . .
is another simple but effective guide. Closed eye requires feeding but prevents wire from jumping out.



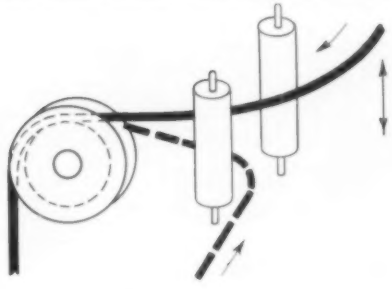
8

Special machine screw . . .
has dia and body length to suit (A), or can be fabricated (B) from standard hardware.



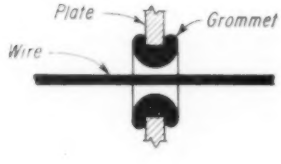
9

Formed spring wire . . .
flexes in use, permits multidirection movement of guided wire.



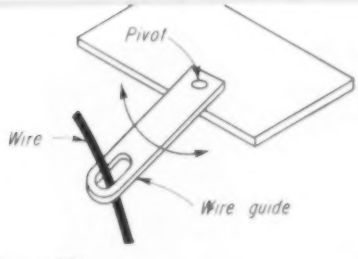
10

Vertical spindles and pulley . . .
allow wire to be fed from left or right side; length of spindle governs allowable up and down movement.



11

Grommet . . .
is inexpensive, easy to assemble, may be either nonmetal snap-in type, or swaged-in metal part.



12

Pivoting guide . . .
allows comparatively wide lateral movement of wire.

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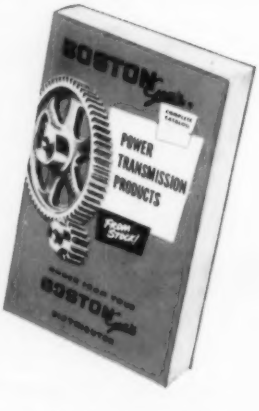

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Yellow Pages

graphic method finds . . .

SHAPE of PIN-CONNECTED LINKAGES

For symmetrical arrangements with 4 or 5 links.

PHILIP O POTTS and R T LIDDICOAT
College of Engineering, Univ of Mich

Freely hanging conveyor-parts, special-purpose suspensions and hinged linkages are examples of some mechanical arrangements that can be analyzed quickly by the chart on the continuing page. It has been designed specifically to find the equilibrium shape of 4- or 5-member assemblies (sketched below). When their weights, link lengths, and spans are changed, their angles α and β will change too.

The chart finds these angles for various combinations of weights, spans, or link lengths. It plots the equations:

$$n = 2 \sin \alpha + 2 \sin \beta$$
$$m = 1 + (2 \sin \alpha + 2 \sin \beta)$$
$$\frac{\tan \alpha}{\tan \beta} = \frac{2W_2}{W_1} + 1$$
$$\frac{\tan \alpha}{\tan \beta} = \frac{Q_2}{Q_1} + 1$$

These are for a practical range of n and m, W and Q, up to 90° and 70° for α and β respectively. The equations are derived from the geometry of the mechanism and a "virtual work" principle, and where the tangent curves and sine curves intersect are values for α and β.

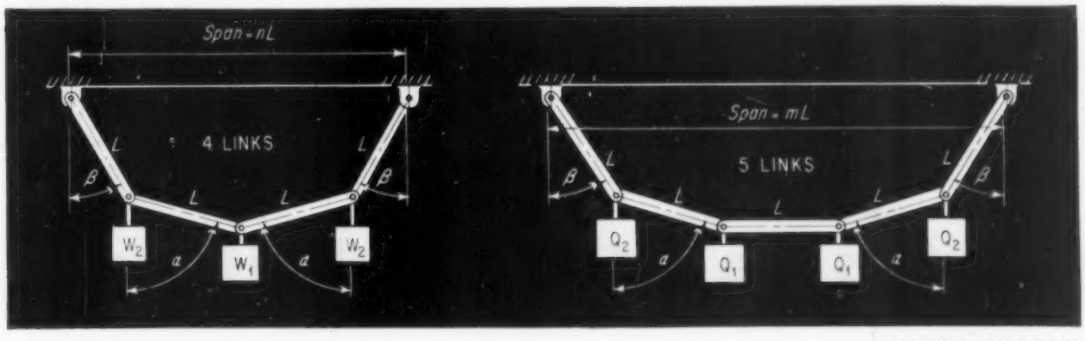
Since equations for the two linkages are similar, any tangent curve holds for a value of Q_2/Q_1 that is twice W_2/W_1, and any sine curve holds for a value of n that is one less than m.

Example: In a 4-link system, the span is $3L$; W_2 loads are twice W_1. Follow the sine curve for $n = 3$, and the tangent curve for $W_2/W_1 = 2$. They intersect at $\alpha = 73°$, $\beta = 33°$. If the system had 5 links, the same angles would be read for a span length of $4L$ and a load ratio of $Q_2/Q_1 = 4$.

Results can also be determined in reverse—if a certain shape or position of a linkage is needed, the necessary loading or span to give required angles can be read directly from the chart. Also, the linkages may be oriented in any direction as long as links are in tension and loads are perpendicular to span. Forces produced by other means than gravity may be substituted for weights.

Link weight may either be neglected or assumed added into W or Q: n is any positive quantity between 0 and 4; m is any positive quantity between 1 and 5.

Equilibrium shape . . .
of hanging, pin-connected linkages depends on weight ratio and link-lengths. Symmetrical weights, and equi-length links in relation to span length are assumed in analytic method described here.



(CONTINUED ON PAGE 73)

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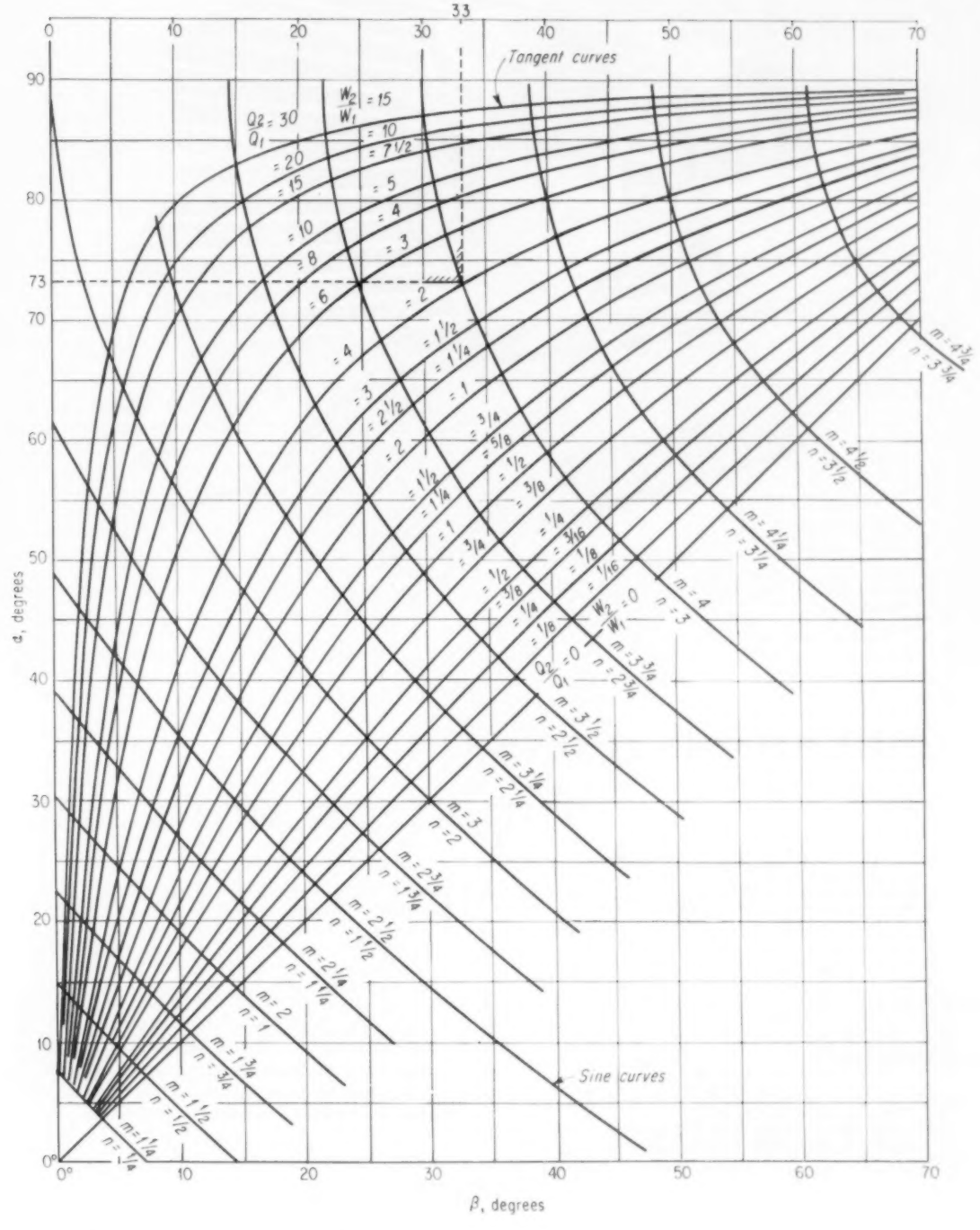
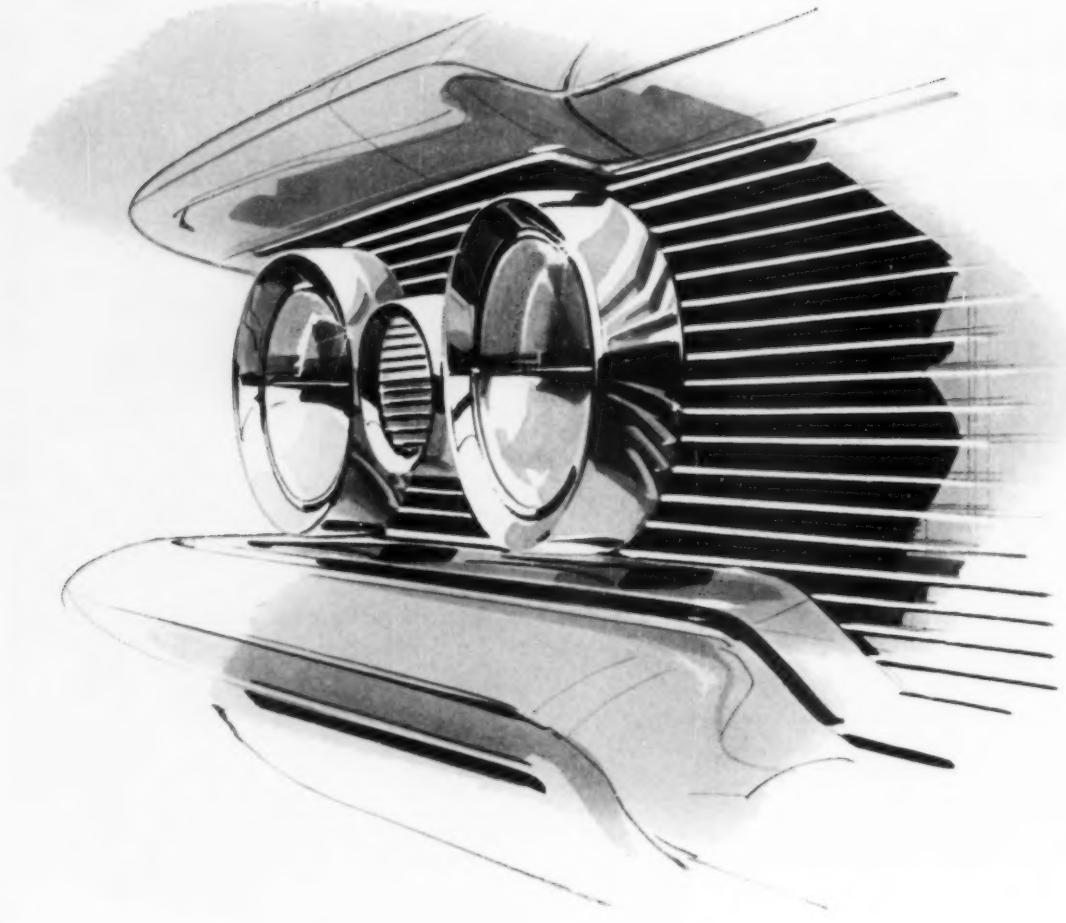
graphic method finds . . .

SHAPE of PIN-CONNECTED LINKAGES (cont.)





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bond similar and dissimilar materials and are used for sealing and filling gaps. The group of high-strength epoxy bonding agents produce a water-soluble bond that is said to resist most acids, alkalies and other chemicals. Said to have high impact, tensile-shear and compressive strength and not to dry out, crack or deteriorate with age. Adhesives will not shrink since they contain no solvent or diluent. One compound achieves a rigid bond and requires no heat or pressure; the other produces a flexible bond with high peel strength. Cures at room temperature. In original containers, adhesives have storage life of 1 yr under normal factory conditions. Available in pint, quart, gallon and 5-gal containers, together with required hardening agent, at from about $3.50 per pt to $18.75 per gal in larger quantities. From stock. **Chemical Development Corp, Danvers, Mass.**

Circle 2, Reader Service Card

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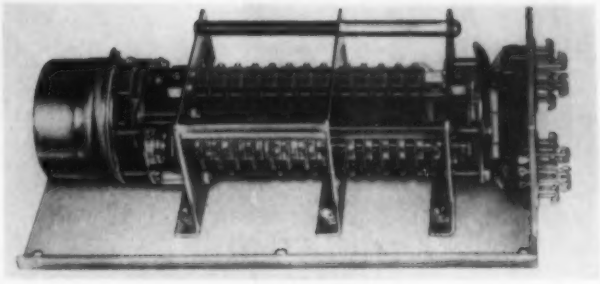
is said to have no secondary pattern that might require matching at joints. Stucco-like texture is produced by a new engraving process and is available in widths to 52 in. max. Texture depth is 0.030 in. Said to be as much as 33⅓% more rigid than other stucco-type textures and up to 50% more rigid than corresponding thicknesses of plain flat sheets. Texture is said to remain distinct after painting and porcelain enameling and to offer resistance to impact scratches, dents, fingerprints. Permits finer perforations with large percent of open area because of increased rigidity. Material is especially suitable for use in covering wide expanses. Adds about 15% to the cost of the basic metal sheet by weight, but over-all savings are said to be about 10% because of gage reductions possible. Most metals are available for 2 to 3 wk delivery. **Ardmore Products Inc, Aldene Rd and First Ave, Roselle, NJ.**

Circle 3, Reader Service Card



Timer programs power supplies . . .

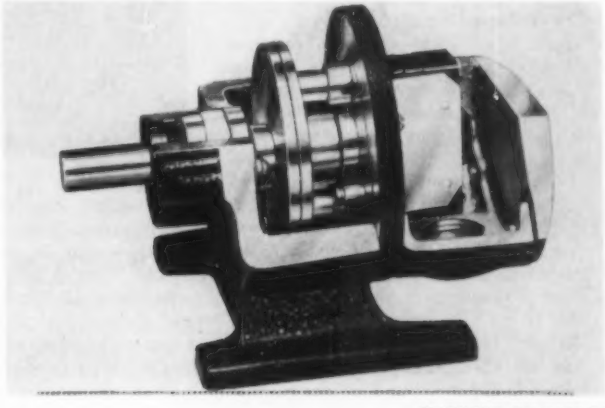
so that voltage is developed in predetermined order. Except for the first, each power supply is turned on about 7 sec after preceding one. Reset time is retarded to permit voltage to decay in each part of circuit in proper order. Timer has 26 load switches that close in pairs. Motor cutoff switch stops motor after total lapsed time of 90 sec. Reset time, controlled by an escapement, is 5 to 10 sec. Motor operates from 115-v, 400 cps; clutch from 20 v dc. Removing clutch voltage resets timer. Withstands 5-g, 300-cps vibration. Operates in temperatures of −67 to 185 F. Unit measures about 4½ x 2½ x 8¼ in. and weighs 60 oz. Priced at $455 in lots of 25. Delivery, 6 wk. **Eagle Signal Corp, Moline, Ill.**

Circle 4, Reader Service Card

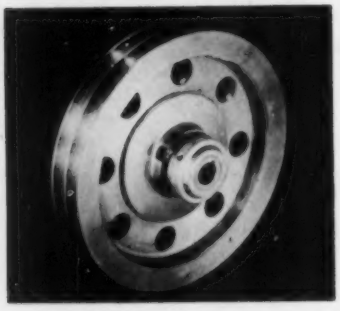
Shaft-driven electrical control . . .

has magnetically actuated contacts operated by hydraulically driven mechanism. Redesigned switches open or close signal circuits on shaft speed acceleration of 15 rpm minimum and can be driven at speeds through 3800 rpm. Silicone oil is used as hydraulic fluid in operating temperatures of −20 to 250 F. Built for general industrial applications, models require about 4 in.-oz driving torque and can be mounted in any position. Available with standard dust and vapor-proof electrical fittings and flange or base mountings. Snap-action, totally enclosed SPDT electrical contacts are rated for 10 amp at 125/250 or 460 v ac; ½ amp at 125 v dc and ¼ amp at 250 v dc. From stock. About $70 per unit. **Winterburn Mfg Co, Putnam, Conn.**

Circle 5, Reader Service Card

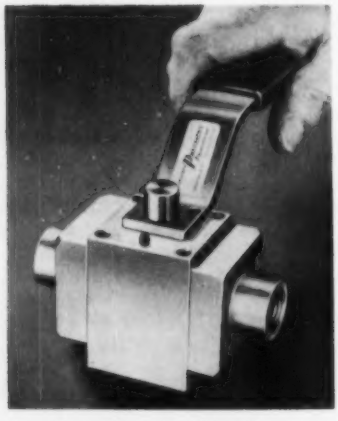


. . . CONTINUED ON PAGE 76



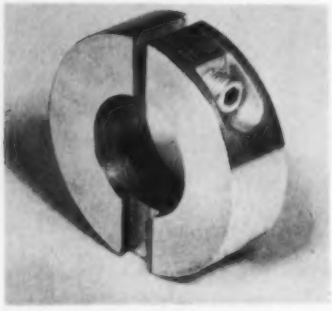
Safety clutch slips . . .
at any preset torque up to 300 in.-lb. Full drive reoccurs when torque falls below preset value. Break-away torque settings are varied with threaded adjustor secured with recessed lock screw. Standard clutches are integral with single or double grooved sheaves for A or B belts. Five pitch diameters range from 6.2 (A belt) to 11 (B belt) in. Units fit on shafts up to 1 in. dia. Standard sheaves have oil-impregnated bearings with provision for re-oiling. Standard clutches range in price to $35. **Edgemont Machine Co, 2200 Home Ave, Dayton 1, Ohio.**

Circle 6, Reader Service Card



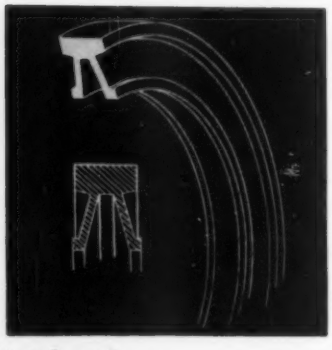
Directional control valve . . .
for 0 to 3000-psi operating pressures provides sufficient hydraulic balance throughout valve to permit low turning torque (less than 5 lb on end of 7-in. handle at 3000 psi) for easy valving of fluids. 2-way valve has low pressure drop (25 psi at 20 gpm in the ½-in. size) and low turning torque. Spherical rotor construction and metal-to-metal floating seals that are both spring- and pressure-loaded are said to achieve positive sealing over a range of pressures. Standard valves, which will handle oils, noncorrosive fluids and lubricated air, are available with ¼, ⅜ and ½-in. dry seal pipe thread ports. Body is aluminum and operating parts are hardened steel. May be used for in-line and panel-mounted installations. Weighs 2 lb 7 oz. **Sarasota Precision Products Inc, 1312 Lime Ave, Sarasota, Fla.**

Circle 7, Reader Service Card



Thrust and torque collar . . .
is spring-locked to a shaft with grip equivalent to a shrink fit. Said to transmit torque loads up to allowable stress of cold-rolled steel shaft and thrust loads that exceed rating of some types of roller thrust bearings without the use of conventional shaft keys, splines, shoulders and snap rings. Assembles with Allen wrench. Will not work loose under severe vibration conditions. In sizes to fit commercial cold-rolled steel shafts from ¾ to 2 in. Offered with or without dovetail slot across the face. Torque collar is locked axially and radially to machine elements such as pulleys, gears, sprockets and cams when assembled on a shaft. **Kolock Products Co, 127 Ridgefield Rd, Lutherville, Md.**

Circle 8, Reader Service Card



Metal seal . . .
for hydraulic and pneumatic systems, combines infinite shelf life and reusability with effective sealing through a temperature range of −350 to 1800 F under pressures up to 20,000 psi. Sealing efficiency is said to be unaffected by normally encountered structural distortion, and mating parts require no unusual machining operations. Standard sizes machined from age-hardened Inconel X are carried in stock from ½ to 6 in. dia. Sizes to 60-in. dia max and of other materials are available on special order. Seal configuration incorporates integral back-up ring with twin lip sealing surfaces. **Cadillac Gage Co, West Coast Div, Costa Mesa, Calif.**

Circle 9, Reader Service Card

Low-density plastic foam . . .
has density of about 2 lb per cu ft, or 30 times lighter than water. Polyethylene foam is said to display high shock-absorbing ability and can be fabricated with conventional woodworking or power tools. Other characteristics include low water absorption and low moisture vapor transmission rates, high solvent and chemical resistance at room temperature, light weight, good insulation value and no odor. Foam may be adhered to itself by use of heat alone or to other materials with commercially available adhesives. Available in 9-ft lengths in two sizes of round stock, flattened ovals and untrimmed planks. Price is currently 22¢ per board ft. **Dow Chemical Co, Midland, Mich.**

Circle 10, Reader Service Card

Snap-action safety gages . . .
for pressure or temperature control can shut down engines or electric motors when oil or water system fails, without separate circuit breakers. One instrument offers indicating gage, safety switch and circuit breaker. Originally developed for missiles, the instruments can be used on generators, air compressors, construction machinery and oil production equipment. **Frank W Murphy Mfg Inc, PO Box 1476, Tulsa, Okla.**

Circle 11, Reader Service Card

High-pressure needle valve . . .
for pneumatic and hydraulic systems utilizes renewable glass-filled Teflon seat for shutoff of hard-to-hold fluids from vacuum

CONTINUED ON PAGE 78

NEW CATALOG

. . . ON ANACONDA FLEXIBLE CONNECTORS OF TEFLON*

ANACONDA Flexible connectors of TEFLON
TYPICAL HOSE ASSEMBLIES of TEFLON
NATURAL COLOR TEFLON CORE IN
–3, –4, –5, –6, –8, –10, –12, –16, –20 SIZES
COVERED WITH TYPE 304 STAINLESS STEEL WIRE BRAID
FITTINGS PERMANENTLY SWAGED: FEMALE 37° SWIVEL, (STRAIGHT, 45° ELBOW, 90° ELBOW); MALE N.P.T.
– 2 –
ANACONDA Flexible connectors of TEFLON
FLEXIBLE HOSE of TEFLON
T-1 HOSE
ANACONDA Flexible connectors of TEFLON
STAINLESS STEEL FITTINGS for FLEXIBLE HOSE of TEFLON
T-1200
FEMALE–37° SWIVEL 90° ELBOW
ANACONDA Flexible connectors of TEFLON
STANDARD HOSE ASSEMBLIES of TEFLON
T-106
Hose Assembly Consists of:
Hose T-1 (page 6)
Fittings T-1100 (page 7)
ANACONDA Flexible connectors of TEFLON
STANDARD HOSE ASSEMBLIES of TEFLON
T-100
Hose Assembly Consists of:
Hose T-1 (page 6)
Fittings T-1000 (page 7)
ANACONDA Flexible connectors of TEFLON
HOW TO ORDER
A. Specify Hose Assembly Number as (T-100)
B. Specify Dash Number for Size as (-4)
C. Specify Length in Inches and Eighths of Inches (104 = 10½")
D. Specify Adapters if Desired
E. Specify Degree of Clockwise Twist Angle of Elbows.
EXAMPLES

Hose assemblies of Teflon, like those illustrated above, were designed to help meet tough problems—temperature extremes, corrosion, high pressure in conveying chemicals, searching liquids, fuel, oils, oxygen, steam—or in hydraulic and conduit applications. A standard assembly may handle your job, help you cut costs. If not, our laboratory and test facilities, as well as engineering services, are available to help in design and development of hose assemblies for special applications. Let us show you how we can help you handle tough problems with Anaconda Flexible Connectors of Teflon. Send for catalog today. 59126

*Teflon is a DuPont trademark for TFE—fluorocarbon resin

WHEREVER CONNECTORS MUST MOVE

ANACONDA® METAL HOSE

An easy-to-use 16-page book with complete data, drawings, photos

Anaconda Metal Hose Division
The American Brass Company
Waterbury 20, Conn. PE

Please send me your free 16-page catalog of Anaconda Flexible Connectors of Teflon, No. TC-101

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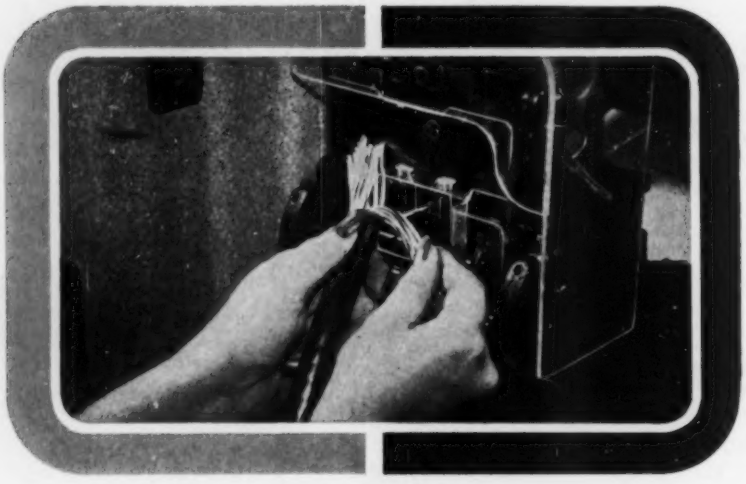
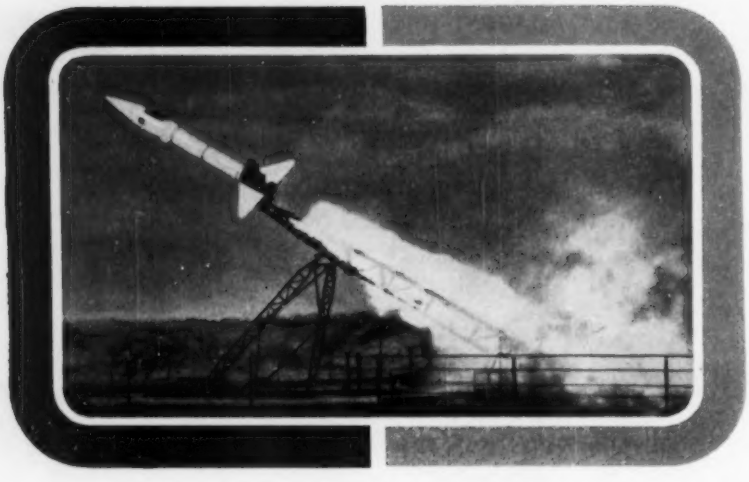
Circuit Terminations Made Here



Do Not Fail Here



Each click of the dies in this A-MP Automachine indicates the completion of another top quality termination. This completely mechanical "crimp" means that there will be no variations in quality, no failures in service. The A-MP terminal actually becomes a homogeneous part of the wire end, supporting it against vibration, resisting corrosion, and affording the soundest electrical performance.

The A-MP Automachine literally "mints" these attachments at the rate of thousands per hour . . . and at a minimum cost to you. Time and time again, AMP has proven that its method costs less and assures higher reliability than any other termination method.

Whether your problem is reliability, production volume or installated cost, AMP can help you. Why not send for descriptive literature today?

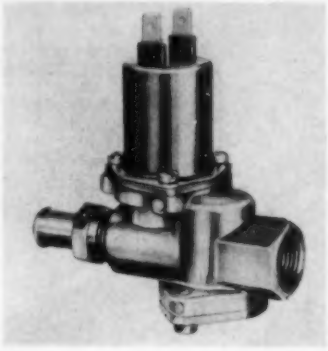
AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

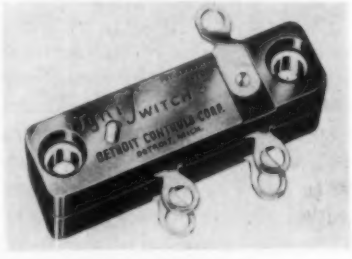
to 6000 psi. Valve has fine pitch regulating treads and taper point on the stem. Standard ports are female pipe NPT or female tubing AND 10050. Constructed of AISI 303 stainless steel with Teflon O-rings and black plastic handwheel. Unit can be panel mounted by removing handle and locknut and slipping valve into predrilled panel hole, then replacing locknut and handle. **Dragon Engineering Co, S Central and Slauson Aves, Los Angeles 11.**

Circle 12, Reader Service Card



Constant fluid flow . . .
and accurate delivery regardless of varying supply pressures is offered by solenoid valve with flow-control device built into valve outlet connection. Unit has positive opening and closing at pressures from 2½ to 200 psi, with flow capacities from ¼ to 6 gpm and for temperatures up to 180F. Special designs can be obtained for temperatures up to 200 F. Accurate delivery of predetermined amount of fluid is said to be possible when mounted in any position. Available with pipe, tubing or hose connections and with top or side terminals, pigtails or flexible metal hose. **Detroit Controls Div, American-Standard Corp, 5900 Trumbull Ave, Detroit 8.**

Circle 13, Reader Service Card



Snap-action switch . . .
has spring mechanism that is single stamping, making bias and stresses that produce snap action inherent in mechanism. Fixed mounting of beryllium copper blade is midway between actuating and contact ends.

(Continued on page 82)

Reduce Costly Wear on Air Equipment

Pipe scale, pipe dope, condensate, emulsified and deteriorated compressor oil — all damaging to connected air equipment — are inherently present in all compressed air systems. Provide for the efficient removal of these contaminants and assure top performance from air actuated devices by specifying a Norgren Air Line Filter in your design.

- **99 Models to choose from** — ⅛", ¼", ⅜", ½", ¾", 1", 1¼", 1½" pipe sizes.
- **Choice of 4 Filter Elements** — 74, 64 or 25 micron . . . 5 micron available in some sizes.
- **Transparent or Metal Bowls**
- **Wide Operating Pressure Range** — Top efficiency at pressures as low as 5 psi—as high as 250 psi for metal bowl type.
- **Wide Operating Temperature Range**—Metal bowl models extend temperature range to 200° F.
- **Automatic or Manual Drain** — Automatic drain eliminates maintenance cost for draining manually.
- **Abrasive Solids and Corrosive Liquids** — are removed from air lines, reducing equipment wear, repair and replacement costs.

Norgren Manual Drain Air Line Filter (Norgren Automatic-Drain Air Line Filter is illustrated above.)

For complete information, call your nearby Norgren Representative listed in your telephone directory—or WRITE FOR DESCRIPTIVE LITERATURE.

If it's Norgren . . . It's Dependable.

C. A. NORGREN CO.

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CIRCLE 130 READER SERVICE CARD 79

Dimensional Control Department at D-J. At D-J dimensional control of die cast parts is so much a part of production routine that a special department is devoted to this purpose. In rooms like this, at every D-J plant, experts verify the dimensions on die castings pulled periodically from the production line.

Outboard motor housing

Instrument panel bezel

Single cylinder engine block

Pinspotter part

At Doehler-Jarvis . . . everything improved production methods

Automatic transmission parts illustrate how much can be done with die cast design. Notice the ganged fluid passageways. Not apparent, but incorporated into the design of each of these parts, are many features that make these parts usable much as they are . . . with a minimum of further manufacturing needed.

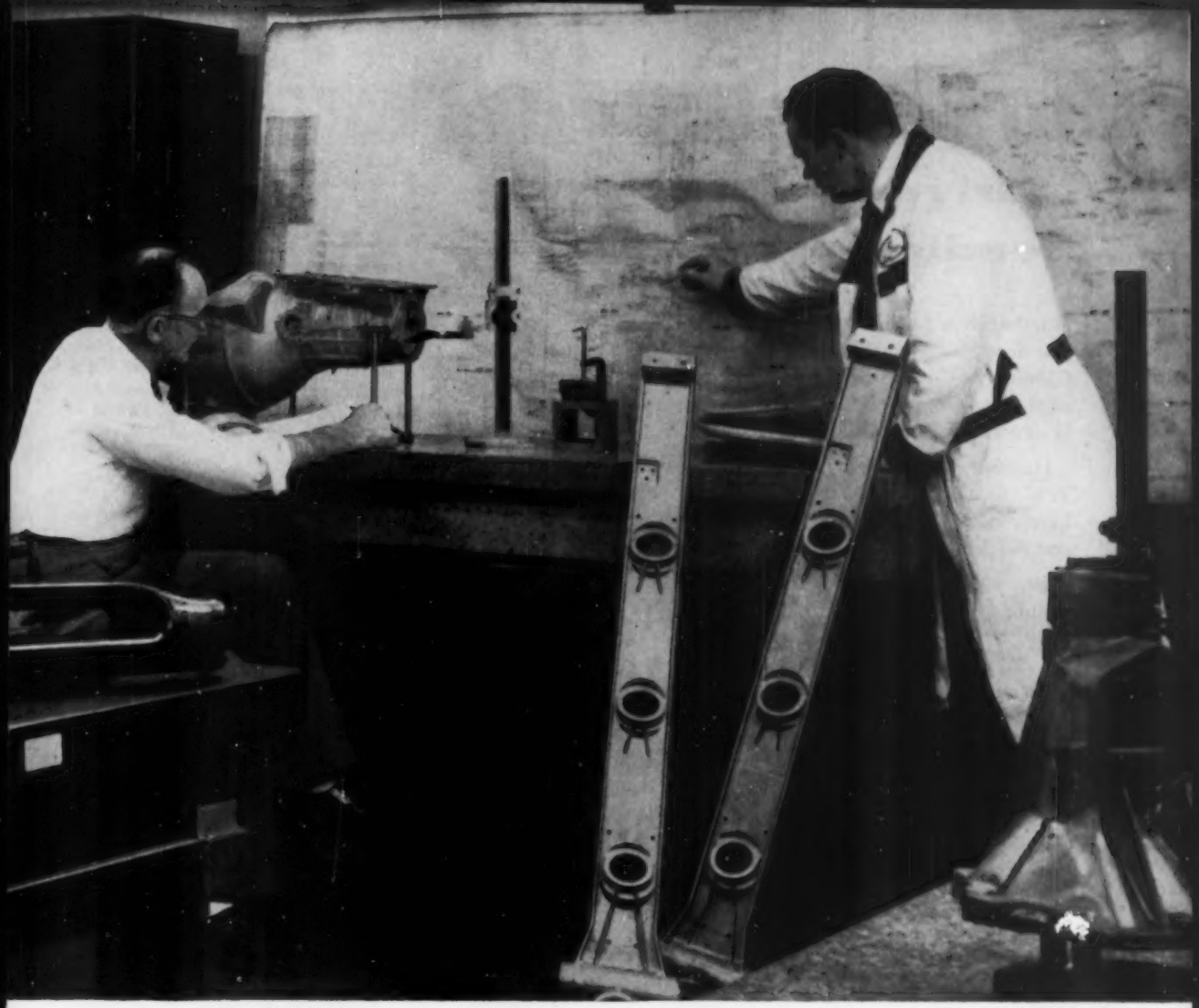
Only a handful of companies have ever taken *full* manufacturing advantage of the inherent opportunities presented by the purchase of die castings — opportunities to so design parts that production *all along the line* is simplified, speeded up, and made more economical.

Frequently die castings are bought under conditions where price is the dominant competitive factor. This approach sometimes makes good purchasing sense. And on the basis of price competition Doehler-Jarvis produces and sells more die castings per year than any other custom die caster.

But there is another, and often more rewarding, way to look at the purchase of die cast parts.

In many instances — most, in fact — a careful analysis of the part by experienced metal production men working in close coordination with equally experienced designers of the dies and the castings reveals ways to:

(1) reduce cost or improve performance of the casting itself.



Transmission housing | Pinspotter arms | Transmission part

needed to help you develop with the help of die castings

(2) introduce design features that eliminate one, many, or all of the machining, finishing or sub-assembling operations that must be accomplished before the part can be incorporated into the end product.

For example. Product engineers have only begun to realize the full range of applications made possible by the high fatigue strength inherent in aluminum die castings . . . by integrating several separate parts into one die casting . . . by ganging fluid passageways (as in automatic transmission designs).

Doehler-Jarvis customers who have taken this suggested broad viewpoint in purchasing their die castings find it pays off . . . sometimes enormously.

No producer of die castings can contribute more to this broad purchasing concept than Doehler-Jarvis.

In any category you care to name . . . research support . . . design help . . . skilled workmanship . . . versatility of metal working equipment (you can even buy *forgings, extrusions and stampings* from D-J) . . . sub-assembly facilities . . . choice of die casting metals and alloys . . . location of plants . . . delivery . . . Doehler-Jarvis provides more facilities than any other producer of die castings.

See what Doehler-Jarvis can do to help you realize the full potentials in die cast parts production. Call us in at an early stage in the design of your next new product or model change.

CIRCLE 131 READER SERVICE CARD

Doehler-Jarvis

Division of

NATIONAL LEAD COMPANY

General Offices: Toledo 1, Ohio

In Canada:

Barber Die Casting Co., Limited

Hamilton, Ontario

Huge H&S Gears

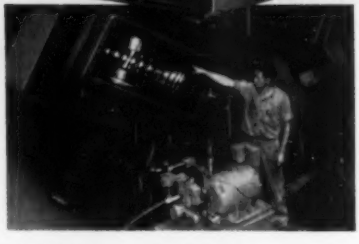
drive world's largest bending machine

Horsburgh & Scott is proud to have supplied the spur gears that drive this machine—designed and built by Bertsch & Co.; Cambridge City, Indiana. Largest of its kind, it bends cold steel plates up to 4¼ inches thick, 16 feet long; weighs over ¾ of a million pounds.

Horsburgh & Scott has facilities to generate gears up to 125″ diameter and to form-mill spur gears up to 160″. We have a complete industrial gear line including worm, helical and herringbone speed reducers.

Tell us your needs. We'll be glad to help you select the proper gearing for you.

2100-ton pressure shapes hull plates for atomic-powered submarines



H & S bronze worm gears adjust forming rolls

Send for your free copy of H & S Gear Catalog No. 57.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
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Elimination of connecting elements in spring design is said to provide high contact pressure, making possible high switch rating in relatively small space. Class 1 switch is said to be unusually small for full 15-amp rated switch and is one of three classes available. Offered in 10 mounting and actuating designs, using solder terminals. Class 4 switches use spade terminals. Both are offered in electrical ratings of 15 amp and ½ hp, 125 and 250 v ac and 10 amp and ½ hp, 125 and 250 v ac. **Detroit Controls Div, American-Standard Corp, 5900 Trumbull Ave, Detroit 8.**

Circle 14, Reader Service Card

Laminated sheathing . . .

adaptable to insulation of aluminum or steel rods for use under high torque conditions will accept multiple set screw mountings of components without chipping or cracking. Sheath is solidly anchored to metal rods, which are available in a wide range of lengths and diameters and in varying degrees of insulation thicknesses. Permits ganged assemblies to be mounted on a single shaft such as are now required for variable condensers. Applicable to all uses that require an insulated shaft that must withstand mounting of components and operate under high resistance. **Richardson Co, 2860 Lake St, Melrose Park, Ill**

Circle 15, Reader Service Card

Pulse-grouping counters . . .

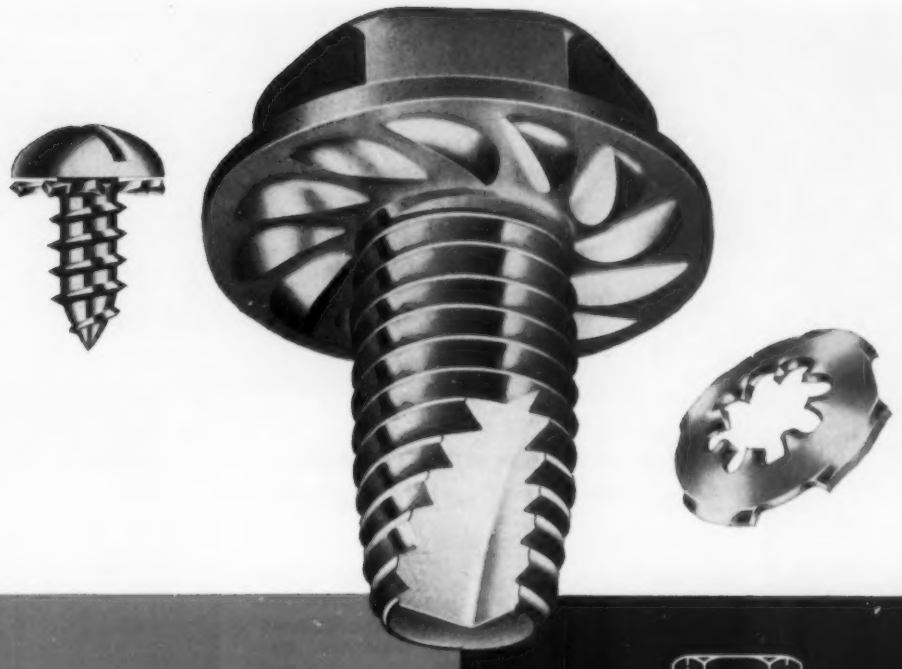
count pairs, quads and other group quantities without pulse-divider circuits. Unit designed to count pairs, for example, accumulates one pulse and registers unit count on second pulse. Five number wheels register unit counts. Available in knob reset basemount, knob reset panel-mount and key reset panel-mount models for ac or dc, all standard voltages to 150. Ac models have built-in full-wave rectification. **PIC Automation Controls Div, General Controls Co, 8072 McCormick Blvd, Skokie, Ill.**

Circle 16, Reader Service Card

Continuous belt control . . .

of tracking and tension is achieved by single, jet-type hydraulic relay that senses location of belt edge, by direct mechanical contact or by noncontact pneumatic edge

(Continued on page 86)



HOW TO SELECT COST-SAVING

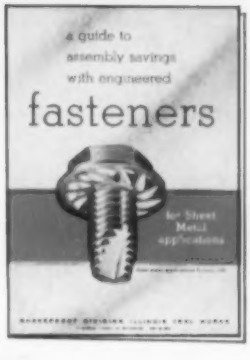
fasteners for sheet metal

A TYPICAL EXAMPLE:
How to Avoid Stripping–

When high stripping torques are required, a Shakeproof NIBSCREW* should be used. "Nibs" under the head take up excessive driver torques and eliminate loose screws, re-work and repair.

You can realize important savings on your assembly line by specifying fasteners that eliminate operations, speed up production and assure highest quality. Engineered Fasteners by Shakeproof now overcome stripping, provide sealing, assure maximum locking and solve countless production problems encountered in mass assembly of products using sheet metal.

SEND FOR NEW SHAKEPROOF BULLETIN NO. 100!
Illustrates twelve typical examples of cost saving fasteners for sheet metal applications. Describes important "check points" for fastener selection. Offers testing samples. Write for your copy today!



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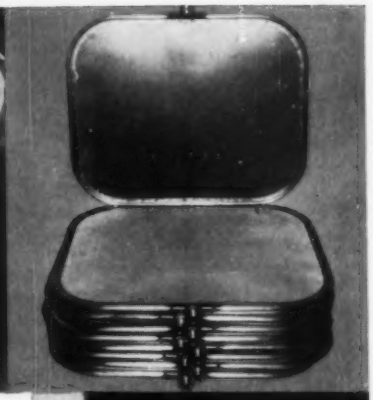

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CAMBRIDGE does . . .

To assure you of wire cloth fabrications that give long and satisfactory performance, we have experienced engineers who can draw up prints for your approval if necessary, and trained production men who can quickly and accurately fabricate parts to your most rigid specifications.

To fill your most diversified bulk wire cloth needs, we have thousands of items in stock—in all meshes, wire sizes, metals or alloys—ready for prompt delivery.

Modern machinery, careful workmanship and constant inspection assure you of exact mesh count and mesh size. And, our field engineers follow up your order to see that our product is giving the best possible service.

We make wire cloth from any metal or alloy—including titanium—in nine basic weaves—from finest to coarsest mesh. Call your Cambridge Field Engineer for information. He's listed in the yellow pages under "Wire Cloth". Or, write for FREE 94-PAGE CATALOG.

The Cambridge Wire Cloth Co.

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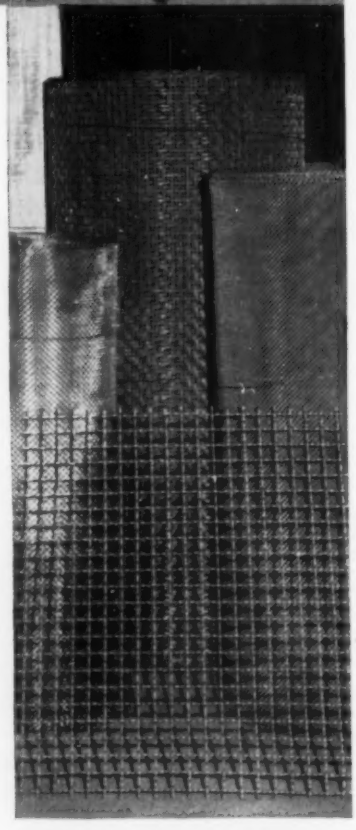
Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications



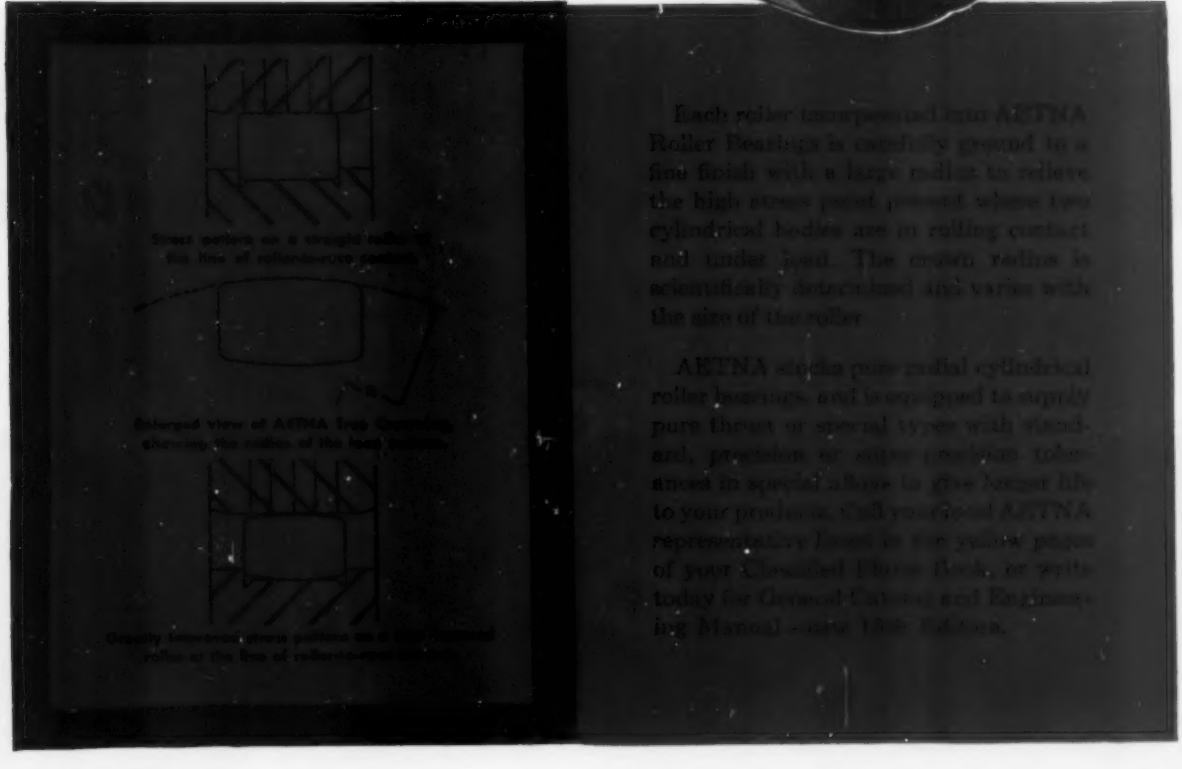
Buy 10%-15% longer bearing life with

AETNA TRUE CROWNED Roller Bearings

Competitive tests of AETNA *True Crowned* Roller Bearings with standard roller bearings by leading machinery builders on identical equipment, with identical load stresses, proved conclusively, time and time again, that AETNA True Crowned Roller Bearings have a 10% to 15% longer service life.

There is no premium for this True Crowned bearing surface. AETNA engineers recommend True Crowned rollers because this design provides the best distribution of stresses across the full length of the roller. You simply buy longer service life at the same cost by specifying AETNA.

The reason for longer bearing life is apparent in these drawings:



Each roller incorporated into AETNA Roller Bearings is carefully ground to a fine finish with a large radius to relieve the high stress point present where two cylindrical bodies are in rolling contact and under load. The crown radius is scientifically determined and varies with the size of the roller.

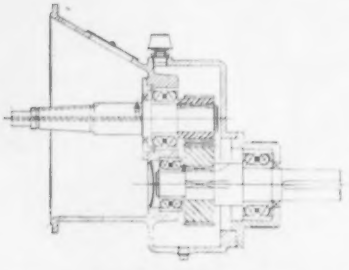
AETNA stocks pure radial cylindrical roller bearings and is equipped to supply pure thrust or special types with standard, precision or super precision tolerances in special alloys to give longer life to your product. Call your local AETNA representative listed in our yellow pages of your Classified Phone Book, or write today for General Catalog and Engineering Manual—new 16th Edition.

AETNA BALL AND ROLLER BEARING COMPANY

DIVISION OF PARKERSBURGH-AETNA CORPORATION • 4600 SCHUBERT AVE. • CHICAGO 39, ILL.

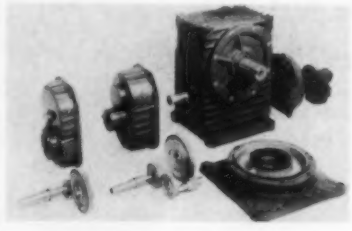
detector. Hydraulically positions takeup pulley to keep belt in line. Bearing blocks of takeup pulley are mounted in slides, each connected to piston rod of hydraulic cylinder. Hydraulic relay discharge port is connected to head end of each cylinder. Alignment is controlled by hydraulic relay, which changes forces against bearing blocks, repositioning takeup pulley to whatever degree is necessary to keep belt in position. Tension of belt is continuously measured and indicated by pressure gages. **North American Mfg Co, 4455 E 71st St, Cleveland 5.**

Circle 17, Reader Service Card



Heavy-duty transmissions . . . offer reduction ratios of 1.43:1 to 2:1 inclusive for either engine rotation or anti-engine rotation. Max input torque is 650 ft-lb with max input speed permissible up to 2200 rpm. Transmissions are said to permit high-speed diesel engines to operate at optimum speed, and equipment being driven to be used at proper rate of speed without undue strain or damage. Gears and shafts in transmission are made of alloy steel. Furnished for attachment directly to engine. Available with SAE No. 1 Bell Housing. Disconnect clutch and pilot bearing are provided to meet engine specifications. Standard output shaft is 3-in.-dia stud shaft with ¾ x ⅜-in. keyway and 5-in. extension. **Cotta Transmission Co, Rockford, Ill.**

Circle 18, Reader Service Card



Worm-gear speed reducers . . . are said to offer five basic improvements over previous standard worm gear drives. Helical attachments for double and triple reduction units combined efficiency of helical gearing with high ratio advantage of worm gearing. Space savings to 50% are claimed, compared to conventional reducers of this type. All ratios from 5 1/6:1 to 1212:1 with center distances from 3 to 21 in. and any horizontal or vertical drive arrangement are available from stock. All units can be supplied with torque control attachment to protect driving and driven equipment from overload damage. **Philadelphia Gear Corp, G St and Erie Ave, Philadelphia 34.**

Circle 19, Reader Service Card

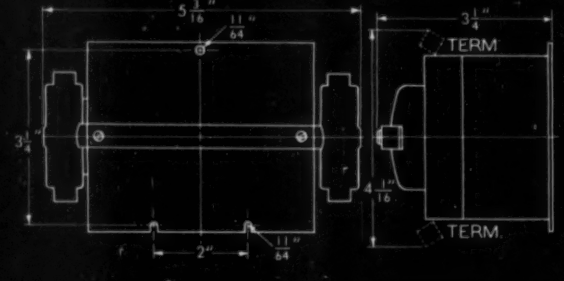
Converter-transducers . . . offer dc output with ac input for measuring, telemetering and control applications. Transducer replaces potentiometer where ac is available. Advantages are said to include no sliding contacts, infinite resolution, resistance to severe shock and vibration, higher linearity and sensitivity to 500 v per in. displacement. Threshold sensitivity is said to be better than 0.0001% of full scale. Temperature range is −320 to 250 F. Made of stainless steel. **Vinson Engineering & Sales Co, 8044 Woodley Ave, Van Nuys, Calif.**

Circle 20, Reader Service Card

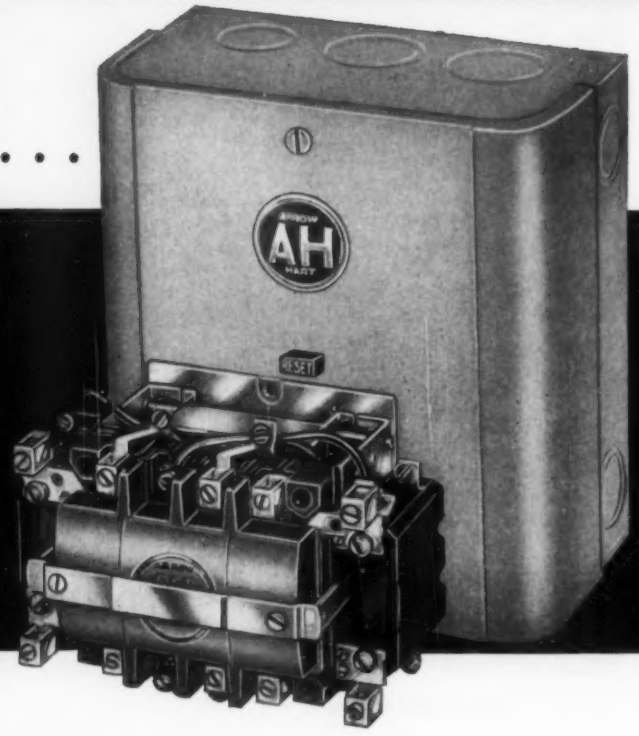
Manometers are compatible . . . with every manometer fluid. Wetted parts are Pyrex, stainless-steel and seals are non-deteriorating. Will not corrode nor be-

ARROW AH HART

1/2 THE SIZE OF CONVENTIONAL STARTERS . . .

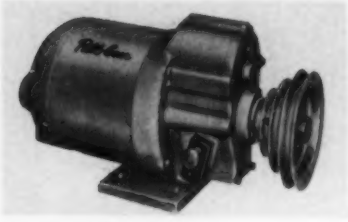


SIZE 1 ILLUSTRATED
Approx. Wt. 3 lb.



come impaired in presence of mercury, water, TBE or hydrocarbon-based fluids. U-tube manometer is available in eight models with scale heights from 3 to 25 in. Single-tube manometer is standard in 13 scale heights ranging from 6 to 100 in. Both units are designed for operation in field or plant. **Dynametrics Corp, Northwest Industrial Park, Burlington, Mass.**

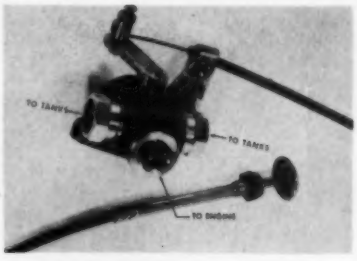
Circle 21, Reader Service Card



Motorized speed reducer . . .

is said to provide extra operating torque at reduced machine speeds, increasing machine capacity. Fingertip controlled, quick-change attachment for belt-driven machines extends machine capacity to permit heavier work on normally light-duty machines. Available in broad range of sizes and ratios to suit most applications. Manufactured with brand-name motors having NEMA-approved hp ratings. Standard reduction ratios range from 6.25:1 to 1:1. Gear housings are cast aluminum alloy. Prices start at $179.50 per unit with ½ hp. motor. **Pull-Gear Co, 25425 Mound Rd, Warren, Mich.**

Circle 22, Reader Service Card



Fuel-selector valve . . .

for use where two or more fuel tanks are part of equipment. Dash control enables operator to switch from one tank to other without looking or moving from driver's position. Designed for heavy-duty vehicles. Snap action makes it fully open or fully closed. Said to need no adjustment after installation and to be unaffected by temperature. It operates with any type of fuel pump and, when transfer from one tank to another is made, empty tank is sealed off. There can be no leakage back to empty tank from full one. Meets Paragraph D, Section E on fuel systems in ICC Motor Carrier Safety Regulations and applicable military regulations. **New Products Corp, 3636 Oakton St, Skokie, Ill.**

Circle 23, Reader Service Card

Servomechanism kit . . .

contains all mechanical parts and tools necessary to construct 1⅞ in. dia mechanism to military specifications. Completed mechanisms can be sealed into standard 2-in. dia enclosures. Rotating units such as motors, potentiometers and synchros are not included, but components can form up to three complete servo loops in a single instrument consisting of as many as six size 8 motors or four size 8 and one size 10. Outputs can be in the form of electrical signals, torque shafts, dial and pointer or counter, if desired. **Servo Development Corp, 567 Main St, Westbury, NY.**

Circle 24, Reader Service Card

360 locking positions . . .

are possible with this index table that measures 6 x 5 x 1⅛ in. high and can be mounted on machine tool or inspection bench in either horizontal or vertical position. Positive indexing is said to eliminate careful visual setting usual in devices of this small size. Position can be repeated

(Continued on page 91)

MOTOR CONTROLS

THE *NEW MODEL* 58 "RA" STARTER

This new starter features the exclusive Arrow-Hart "Right Angle" mechanism with magnet operating through a simple bellcrank lever. The resulting mechanical advantage lets a much smaller, lighter magnet outperform older, direct-acting types. Control size and weight are reduced by half . . . performance and dependability are greatly improved.

New Model 58 Size 1 Starters offer:

- **Wide Voltage Range Coils**
  Standard coil voltages are 110-120, 208-230, 440-480 and 550-600, at 60 cy.
- **Epoxy-Resin Encased Coils**
  Better protection against physical abuse, humidity, oil, fungus, shock, vibration, and other environmental conditions.
- **Wrap Around Enclosures**
  Make starters easier to install, wire, inspect and maintain.
- **Wiring Lugs**
  Make straight-thru front wiring easy.

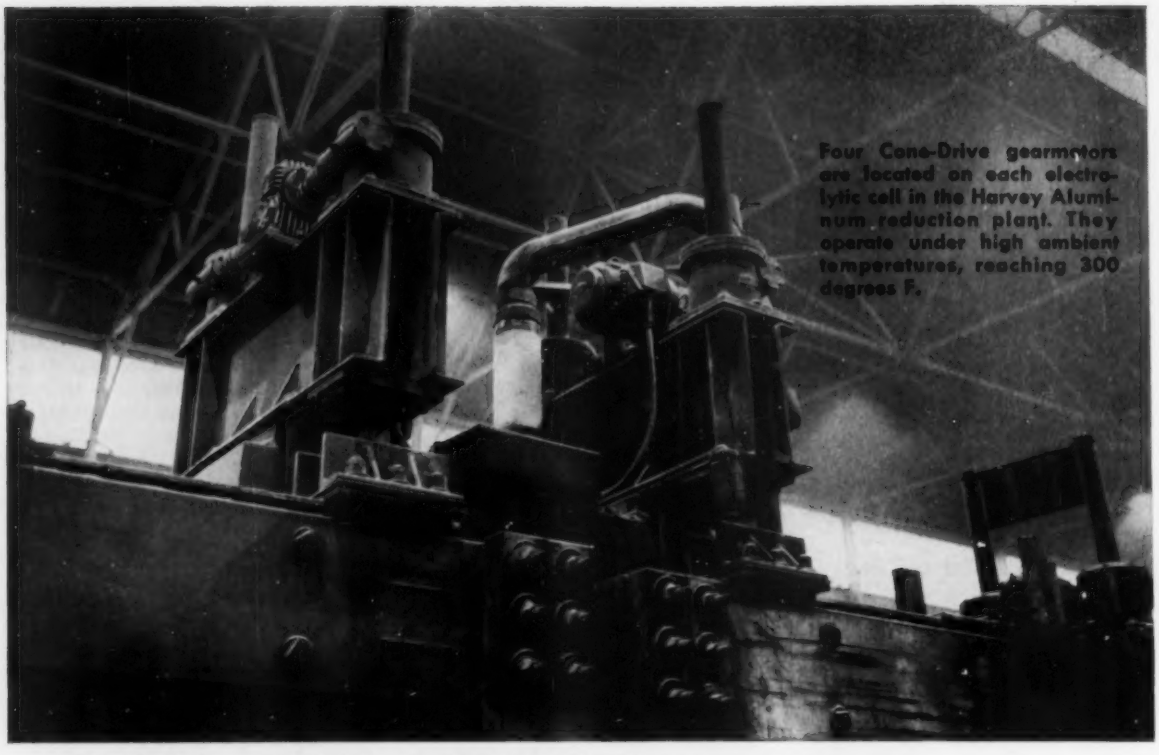
Available in a complete line, NEMA Sizes 0 through 5, in Non-Reversing, Reversing Multi-Speed, Reduced Voltage Starters and others.

Write today for Motor Control Handy Reference Catalog No. 14 to The Arrow-Hart & Hegeman Electric Co., Dept. PE, 103 Hawthorn St., Hartford 6, Conn.

ARROW-HART of HARTFORD

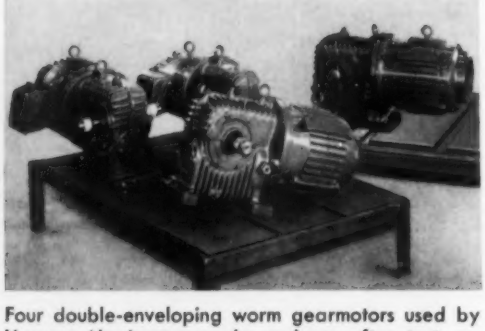
Quality since 1890

MOTOR CONTROLS • ENCLOSED SWITCHES • APPLIANCE SWITCHES • WIRING DEVICES



Four Cone-Drive gearmotors are located on each electrolytic cell in the Harvey Aluminum reduction plant. They operate under high ambient temperatures, reaching 300 degrees F.

1,000 CONE-DRIVE Gearmotors to produce 100,000,000 lbs per year at Harvey Aluminum



Four double-enveloping worm gearmotors used by Harvey Aluminum are shown here after test run in Cone-Drive plant. They were palletized in groups of four for shipment to Oregon smelter.

From its modern reduction plant at The Dalles, Oregon, Harvey ships primary aluminum in pig, ingot and billet forms all over America. The smelter includes the latest and most efficient equipment and operating techniques. Reflecting this modern equipment are 1,000 Cone-Drive double-enveloping worm gearmotors, used to control the height of anodes and casings in relation to the molten aluminum bath in each of the electric furnaces. Annual capacity is more than 100-million pounds.

The gearmotors are operated under high ambient temperatures that reach 300° F. This was an important consideration in Harvey's selection of Cone-Drive gearmotors. In addition, the ability to withstand the full force of stalled driving motors and constant reversing operations figured in Cone-Drive gearing's selection.

Cone-Drive double-enveloping worm gearmotors are available in a wide variety of styles and sizes. Models include standard shaft or hollow shaft with worm over or under or gearshaft vertical. Capacities range from ¼ to 40 HP and reductions from 3.3:1 to 240:1. Ask for Catalog No. 58 for complete specifications.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS

DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

CIRCLE 137 READER SERVICE CARD

3 NEW BELLOWS DEVELOPMENTS FROM Flexonics

new FLEXONICS Hastelloy* alloy B bellows— to strong chemicals

FLEXONICS new Hastelloy alloy B bellows open new opportunities to the designer for efficient, dependable control of flow and pressure of certain highly corrosive media. For example Hastelloy alloy B is well suited to handle hydrochloric acid at all concentrations and temperatures, including the boiling points, and has good resistance to sulphuric and phosphoric acid, hydrogen chloride gas, as well as many other severely corrosive media. The metal is similar in strength and ductility to alloy steel. FLEXONICS Hastelloy alloy B bellows can be supplied in sizes from 13/32" I.D. to 5-3/4 I.D.

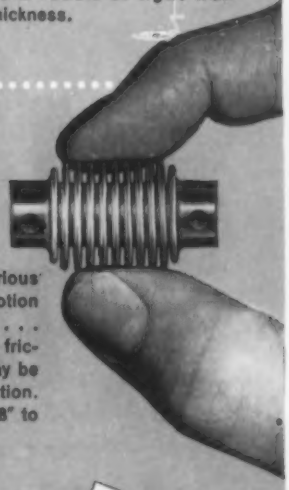
*Registered trade mark Union Carbide Corporation

new miniaturized FLEXONICS bellows... nominal 5/32" I.D.

Seamless, hydraulically formed precision bellows in a wide range of metals and performance characteristics. Exceptional strength . . . and extreme sensitivity to temperature and pressure changes as a result of light wall thickness.

new FLEXONICS miniaturized flexible couplings from stock

As small as 15/32" O.D. in various metals. Transmit rotary motion with absolute zero backlash . . . minimize bearing wear and friction. Direction of rotation may be reversed without loss of action. Accommodate shaft sizes 1/8" to 5/16" diameter.



For design applications that involve the measurement of pressure or temperature . . . a flexible sealer . . . or even low-torque power transmission — a Flexonics Bellows can be your answer. Send an outline of your bellows applications — the Flexonics Application Engineering Staff will be pleased to make recommendations. If you prefer write for the Flexonics Bellows Design Guide . . . 20 pages of valuable information.

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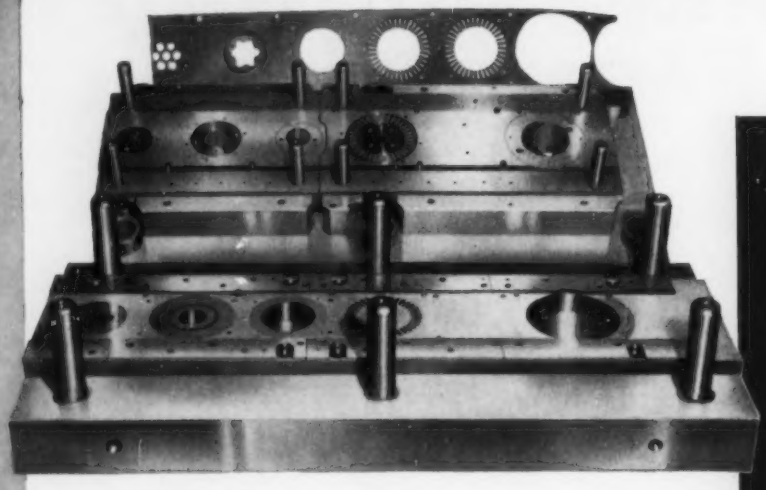

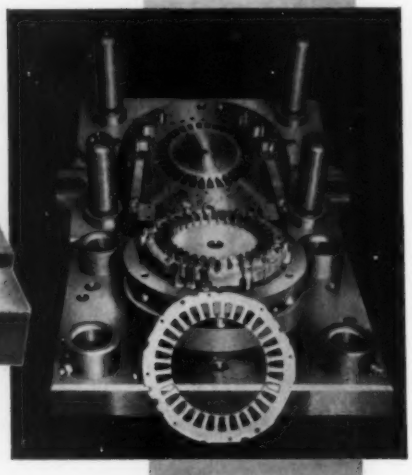

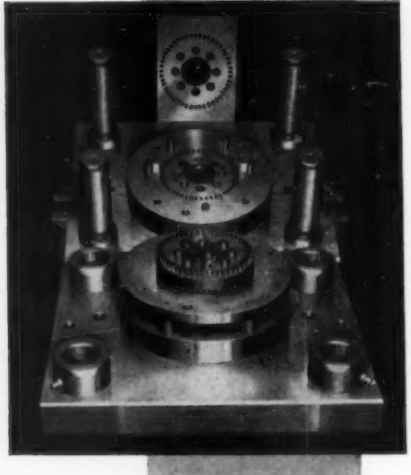

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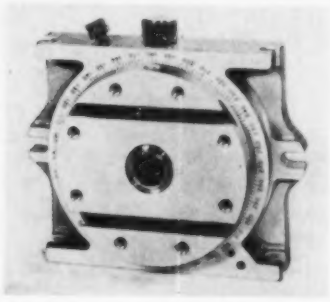
WE WOULD BE PLEASED TO QUOTE ON YOUR REQUIREMENTS



within 2 min of arc. Constructed of heat-treated lightweight alloy castings. **Calectron Inc, 2444 Beverly Rd, St Paul 4.**

Circle 25, Reader Service Card

Variables sampler . . .

offers method of fulfilling requirements of acceptance sampling procedures specified in MIL-STD-414 and provides self-contained basis for independent inspection control system. Sampler consists of base, etched scale arm with two sliders and set of 16 graphs, which present curves for each sample size letter B through Q. Graph sheets are furnished in transparent plastic envelope. In operation, under two-limit specification, outer slider and scale are positioned to reflect acceptable quality range of specification; inner slider is positioned and graph sheet is marked to show deviation of sample mean. Scale and inner slider are moved to reflect spread of sample and graph sheet is marked. Acceptance or rejection is obvious from two marks on sheet. **American Research & Mfg Corp, 920 Halpine Ave, Rockville, Md.**

Circle 26, Reader Service Card

Externally adjustable flow . . .

regulator is for use in laboratories to ascertain exact flow requirements of hydraulic systems. Available in pressure ranges of 5 to 6000 psi, with flow of 0.5 to 32 gpm. Temperature range is –65 to 400 F. **Vinson Engineering & Sales, 8044 Woodley Ave, Van Nuys, Calif.**

Circle 27, Reader Service Card

Delayed setting action . . .

facilitates accurate positioning of a transparent adhesive film. With protective wax coating removed, film becomes tacky enough to allow approximate positioning. Adhesive sets after about 24 hr and forms a permanent bond with paper or cloth to which it was applied. Acetate film, 0.0015 in. thick, is washable, waterproof and chemically stable. Matte outer surface will take pen and pencil. Produced in sheets and rolls and as a mending tape. Dispenser separates tape from wax paper backing. **Keuffel & Esser Co, Hoboken, NJ.**

Circle 28, Reader Service Card

SEALING DOMESTIC APPLIANCES IS A REAL CHALLENGE, TOO!
Standard 6A Seal with specially designed seat conforming to impeller contour so as to promote good water flow characteristics.
Limited axial room and large diameter are mechanical requirements in this washing machine seal. Design features multiple spring construction for even face loading.
FIVE ADAPTATIONS OF THE John Crane TYPE 6A SEAL for four different appliance manufacturers
Seal features outer periphery face construction to best service garbage disposal conditions.
Two sealing points in a washing machine with widely differing physical limitations, yet seals for both retain full advantage of diaphragm action, shouldering points and positive drive.

Soapy water, detergents, bones, grit and lint . . . all these combine to make appliances a hard-to-handle sealing problem. Add that to a very limited space factor, and you've got a real set of conditions on your hands.

"John Crane" engineers have solved these problems and thousands of other shaft sealing applications on all types of commercial and industrial equipment. We know that we can be of the same help to you.

That's why . . . as one design engineer to another . . . we urge you to let us work with you in adapting or developing the proper seal for your application.

Tell us about your requirements or write for our fully illustrated Bulletin S-204-3 on "John Crane" Shaft Seals.

Crane Packing Company, 6445 Oakton Street, Morton Grove, Illinois, (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

CRANE PACKING COMPANY

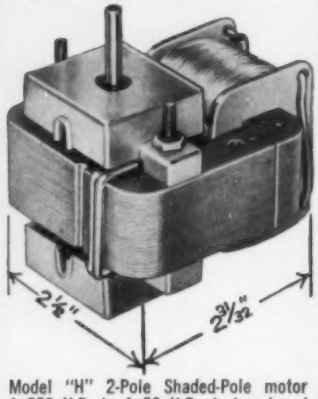
GENERAL INDUSTRIES

Smooth Power

AC MOTORS

1/1600 H.P. to 1/20 H.P.

Greatly Increased Oil Capacity... for long range peak efficiency



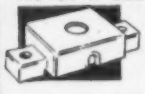
Model "H" 2-Pole Shaded-Pole motor 1/550 H.P. to 1/50 H.P. designed and constructed with features that assure thousands of **extra hours** of service under the most adverse operating conditions. Rugged, quiet, smooth running. Available in nine models that cover a wide range of applications.

OIL CAPACITY MANY TIMES GREATER THAN CONVENTIONAL MOTORS

Oversized oil bearing reservoirs hold considerably more oil and wicking. A revolutionary new method of packing the wicking assures equal distribution of oil at all times resulting in quieter operation and longer trouble-free life.

DIE-CAST BEARING BRACKET

The new "H" Motor design includes a rugged die-cast bearing bracket that insures permanent precision alignment and adds to the over-all durability.



Motors For All Types of Applications

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THE GENERAL INDUSTRIES CO.

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 103.

SWITCHES AND ACTUATORS—Catalog ES-59, 48 pp. Contains definitions of terminology used in the industry, as well as photos, specifications, dimensional drawings and modifications on subminiature switches, subminiature snap-action switches, 1-2-3 and multi-pole types and their actuators. Also basic information on lighted pushbutton panel switches, environment-free switches, hermetically-sealed switches and die-cast enclosed switches. Electrosnap Corp, 4218 W Lake St, Chicago 24.

Circle 29, Reader Service Card

HYDRAULIC PUMPS—Catalog, 36 pp. Ratings, operating data and dimensional information. Includes outline drawings, photos, cross-section view and curves. With SAE standards, useful hydraulic formulae, torque and temperature conversion charts. Clark Equipment Co, Benton Harbor 6, Mich.

Circle 30, Reader Service Card

SOCKET SCREWS—Catalog 490C, 28 pp. Describes and illustrates line of socket screws. Contains revised dimensions approved by Socket Head Cap and Set Screw Manufacturer's Standards Committee. Parker-Kalon Div, General American Transportation Corp, Clifton, NJ.

Circle 31, Reader Service Card

EXTRUDED AND COATED TUBINGS—Manual 59T, 20 pp. Provides specifications and service information on extruded and coated tubings, heat-treated glass sleeving and identification markers. Also covers footage requirements for cut pieces and standard conditions of sale. Wm Brand & Co Inc, Willimantic, Conn.

Circle 32, Reader Service Card

SELECTING SEALS—Fact book, 24 pp. Information on groove design, squeeze, operating characteristics and other design data, as well as dimenisons, numbering systems and applications of common seals. Also gives tips on installation. Includes charts covering Aeronautical Material Specifications, SAE-ASTM material specifications, MIL-R-5847C specifications, UL-approved rubber compounds and information about media in which they may be used. Final section describes a patented seal consisting of a Teflon boot used in conjunction with a standard O-ring. Minnesota Rubber Co, 3630 Wooddale Ave, Minneapolis 16.

Circle 33, Reader Service Card

PRESSURE GAGES—Catalog G-58, 48 pp. Descriptions and dimensional information on pressure gages and accessories. With photos, sketches, dimensional drawings and diagrams. Kunkle Valve Co, 120 S Clinton St, Ft Wayne, Ind.

Circle 34, Reader Service Card

ALL-STEEL MOTOR REDUCERS—Revised bulletin 3100, 28 pp. Describes motors and motor-gear reducer units. Revisions include changes in selections, dimensions and weights to incorporate re-rated NEMA standard motors from 1 through 75 hp, addition of service classifications and increased overhung load and thrust capacities for first 3 sizes. Falk Corp, Dept 255, Box 492, Milwaukee 1.

Circle 35, Reader Service Card

VINYL-CLAD STEEL—File folder, 6 pp. Properties and characteristics of vinyl-metal laminate with fabrication and application information. Includes sample. Arvin Industries Inc, Columbus, Ind.

Circle 36, Reader Service Card

HEAVY PRESS ALUMINUM EXTRUSIONS—Brochure, 12 pp. Covers design and production of heavy press extrusions. Includes types of sections producible and standard manufacturing limits. Harvey Aluminum, 19200 S Western Ave, Torrance, Calif.

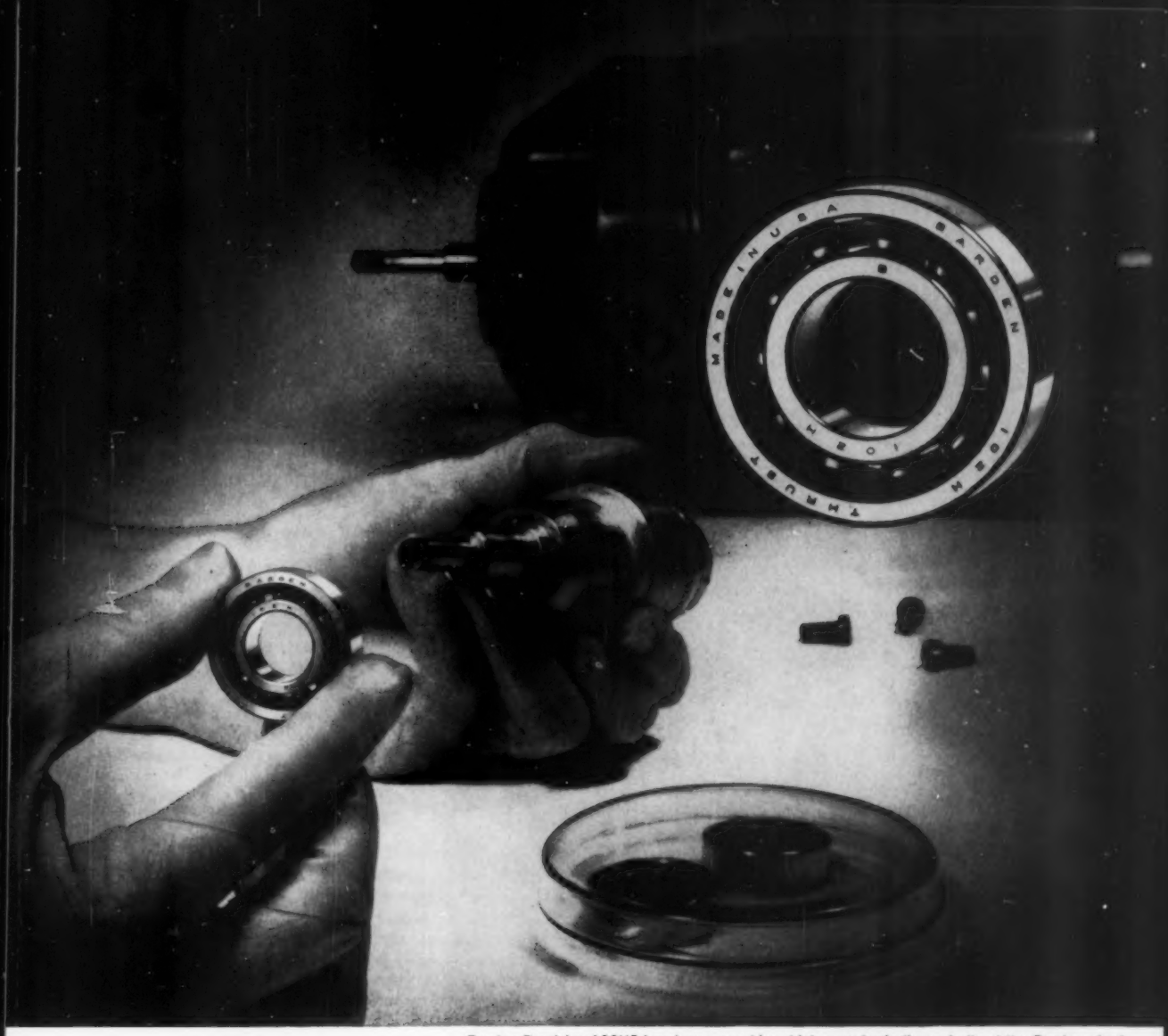
Circle 37, Reader Service Card

SILICON DIODES AND TRANSISTORS—Booklet QA-60-28-001, 12 pp. General descriptions, characteristics, performance information and applications of silicon diodes and transistors. Also discusses research and development and production facilities briefly. Sperry Semiconductor Div, Sperry Rand Corp, South Norwalk, Conn.

Circle 38, Reader Service Card

BEARING FITS—Manual, 8 pp. Contains instructions for preventing premature bearing failures and off-schedule removals; procedures on obtaining accurate bearing

(Continued on page 94)



Barden Precision 102H5 bearing as used in a high speed grinding spindle at the Barden plant

BARDEN *bearings help Barden make better bearings*

Fringecount Micrometer, an ultra-precision interferometer, is used by Barden for the absolute measurement of dimensional masters to one millionth of an inch. This basic reference gage provides the ultimate in quality control instrumentation, assuring consistent accuracy of Barden Precision ball bearings.

Precision spindle performance demands low vibration, high rigidity and maximum rotational accuracy at extreme speeds, all maintained over extended periods of service.

Because *Barden Precision* spindle bearings meet all these requirements — and more — they are used in the most precise machine tools being built today. To the user of precision spindles, they bring high performance and dependability that is measured by the superior quality of machine output.

In the Barden plant the closest-tolerance grinding operations are performed on high speed grinders fitted with *Barden Precision* spindle bearings. Barden production men discovered long ago that it takes bearings of the highest precision and performance to grind bearing parts to their rigid specifications.

In this unique cycle of manufacturing, *Barden Precision* spindle bearings help make better Barden bearings of all types and sizes . . . better because Barden production experts are their own most critical customers.

The result: spindle bearings that measure up to the highest standards of production quality.

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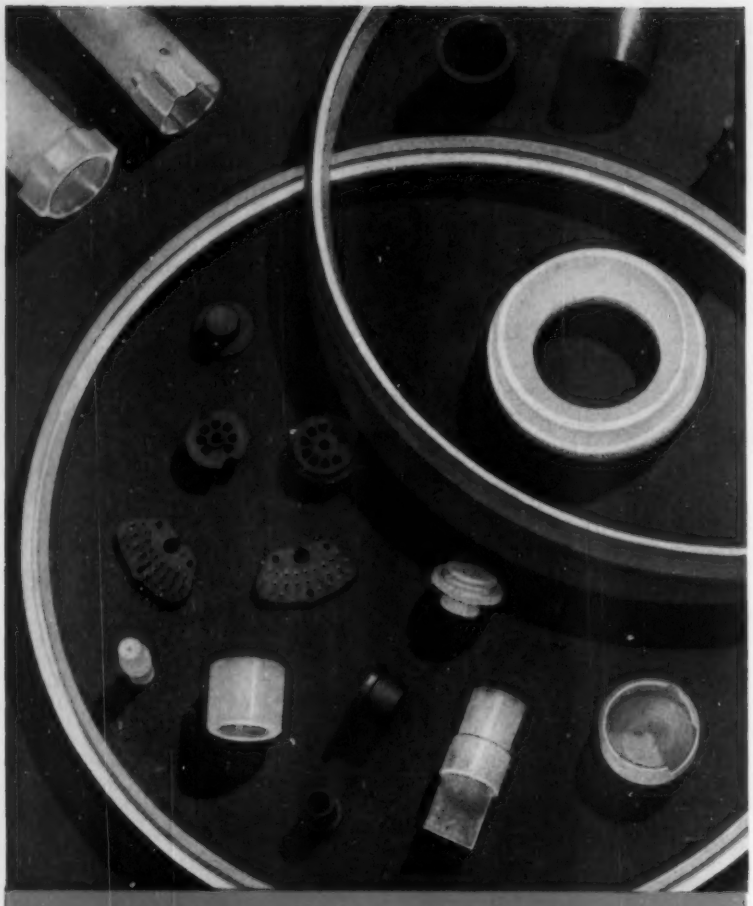
SPECIFY BARDEN PRECISION BALL BEARINGS FOR: MACHINE TOOL AND TEXTILE SPINDLES • INSTRUMENTS • AIRCRAFT ACCESSORIES • COMPUTERS AND RECORDERS • OTHER PRECISION APPLICATIONS

CIRCLE 142 READERS SERVICE CARD



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United States Gasket

Plastics Division of GARLOCK

fits and engineering information on bearing fits on all antifriction bearings. Bearing Inspection Inc, 3311 E Gage Ave, Huntington Park, Calif.

Circle 39, Reader Service Card

METAL PROTECTIVE PIGMENT – Booklet, 8 pp. Covers characteristics and properties of anticorrosive pigment suited for formulation of primer, intermediate and finish coats, providing cumulative protection. Eagle-Picher Co, American Bldg, Cincinnati 1.

Circle 40, Reader Service Card

PLASMA ARC PLATING—Booklet, 8 pp. Describes coating service for metals for high-temperature applications, and a process for fabricating shapes from refractory and other metals. Linde Co, Div Union Carbide Corp, 30 E 42nd St, New York 17.

Circle 41, Reader Service Card

CALIBRATING PROCESS-CONTROL SYSTEMS—Catalog, 16 pp. Tells how to calibrate systems with particular emphasis on those using proportional currents for signal transmissions and telemetering. Gives electrical and mechanical specifications for three instruments. Includes instrument application data. Diagrams show how to interconnect instruments. Technique Associates Inc, 1413 N Cornell Ave, Indianapolis 2.

Circle 42, Reader Service Card

ROOM-TEMPERATURE-VULCANIZING SILICONE RUBBER – Bulletin CDS-170, 10 pp. Describes material for electrical potting and encapsulating, for flexible mold-making materials and for high- and low-temperature sealing and caulking. Includes product and application data for three compounds. General Electric Co, Waterford, NY.

Circle 43, Reader Service Card

TRANSISTOR MAGNETIC SERVO AMPLIFIERS—Bulletin S-961, 8 pp. Specifications and performance data for high-power transistor magnetic servo amplifiers. With photos, diagrams and charts. Transfer characteristic curves are shown for all models listed. Magnetic Amplifiers Inc, 632 Tinton Ave, New York 55.

Circle 44, Reader Service Card

HELICAL GEARMOTORS—Bulletin GEA-6704, 16 pp. Construction features and applications of helical gearmotors and speed-reducer line. Cutaway drawings show maintenance features. General Electric Co, Schenectady 5.

Circle 45, Reader Service Card

MAGNETIC FLOWMETER—Catalog 10D1416, 6 pp. Gives principle of operation and advantages of obstructionless

(Continued on page 98)

Here's proof of economy with FALK Shaft Mounted Drives

PROBLEM—For many years, a prominent Eastern abrasives manufacturer* experienced high maintenance and down-time costs, as well as excessive noise and vibration, in the operation of 19 pebble mills driven by open spur gears. Drive gears and jack shaft pillow blocks required frequent repairs or replacement, and trunnion shafts often failed, due to radial overloading of the bull gear when broken pinion teeth bottomed between gear teeth.

SOLUTION—After numerous unsuccessful approaches to these problems, the solution was found by mounting a Size 315J FALK Shaft Mounted Drive directly on the mill drive trunnion. This eliminated objectionable gear noise and vibration...greatly reduced costly down-time and loss of production...and cut annual maintenance and replacement expenses as indicated by the following figures taken from the customer's records:

Spur Gear-and-Pinion Drive		FALK Shaft Mounted Drive	
Bull Gears	$ 56	VEE Belts	$ 30
Pinions	120	FALK Shaft Mounted Drive (based on 10-year life)	70
Pillow Blocks	90		
VEE Belts	30		
Trunnion (5-year life)	100		
Annual cost	$396	Annual cost	$100
		ANNUAL SAVINGS	$296

IF OBSOLETE DRIVES ARE COSTING YOU MONEY, a change to Falk All-Steel Shaft Mounted Drives can effect important savings in money and production. Used on almost any type of machine, these compact, rugged units are establishing new standards of economy and efficiency in many industries. Specify FALK Drives on your purchased equipment...For full details, **write for Bulletin 7100.**

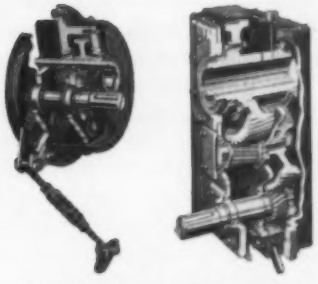
*Name on request

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in Most Principal Cities

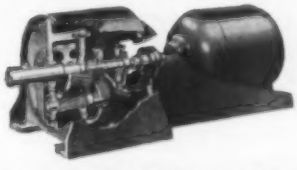
To get the right drive for your application, specify FALK®



SHAFT MOUNTED DRIVES

Horizontal or vertical units—½ to 50 hp—420 to 5 rpm—single and two double reduction ratios—output torque ratings up to 41,000 lb-in (consult factory for higher torque capacity).

• • •



ALL-MOTOR® MOTOREDUCERS

Sizes up to 75 hp—furnished with or without standard foot-mounted motor—standard output speeds 1.2 to 520 rpm (with 1750 rpm motors)—ratios as high as 54,000:1 in semi-standard designs. Integral units (gearmotor type) also available. Ask for **Bulletin 3100.**

• • •

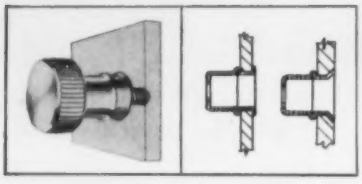
FALK Drives are available from factory and distributor stocks from coast to coast. Consult your Falk Representative or Distributor.

FALK

...a good name in industry

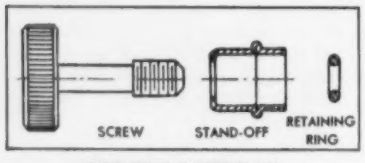
SELECT CLOSURE HARDWARE TO IMPROVE UTILITY, APPEARANCE, AND TO LOWER COST

QUICKLY INSTALLED SOUTHCO CAPTIVE PANEL SCREWS END MISALIGNMENT PROBLEM . . .



Simplicity of design contributes to clean, distinctive appearance and fast, low-cost installation. Stand-off is slipped into panel hole and secured by flaring. Screw is passed through stand-off and made captive by vinyl o-ring.

"Floating" screw design eliminates costly close tolerance manufacture and permits easy engagement regardless of panel distortion encountered under adverse use conditions.



SPECIFICATIONS

Material: Screw is brass, chrome plated; can be supplied in stainless steel. O-ring is vinyl plastic.
Overall length of screw: 1 3/16"
Depth of screw head: 1/4"

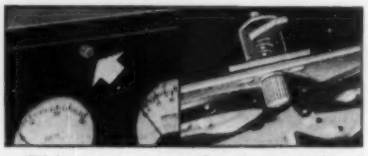
Sizes:

SCREW HEAD DIAMETER	THREAD SIZE
3/4"	1/4-20
5/16"	1/4-20, 12-24
3/16"	10-24,10-32

Length of thread: 3/8"

Screw head is supplied plain, as shown, or slotted for screw driver.

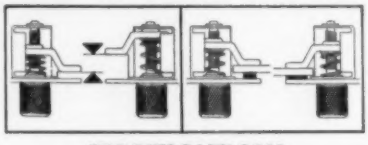
PRE-ASSEMBLED PAWL ADJUSTS TO DESIRED THICKNESS AND PRESSURE



This neat, compact Southco panel and door fastener is supplied assembled, requires but two rivets or bolts for low cost installation. It is available in three models—large, intermediate and midget.

The unique feature of Southco Pawl Fasteners is the fact that, by merely turning the knob, the pawl is adjusted to a wide range of frame thicknesses. This assures a tight grip without precision setting regardless of variations in frame or door dimensions or changes that are produced by wear or warping of sheets.

Pressure exerted by the pawl on the frame is controlled in the same way, by merely turning the knob. Against gasketed frames, pressure can be easily applied to compress the gasket.



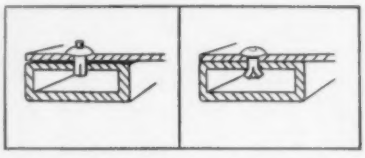
SPECIFICATIONS

Knob: Cadmium or chromium plated steel.

Head Styles: Protruding ribbed or knurled knob; flush screw driver slotted for large size only.

	LARGE	INTERMEDIATE	MIDGET
Knob diameter	7/8"	5/8"	11/32"
Total width	2 1/2"	1 3/4"	1 1/8"
Total height	1 5/16"	7/8"	35/64"
Back of panel depth	1 23/32"	1 1/4"	7/8"
Knob length	1 1/8"	15/16"	9/32"

FAST, HAMMER-DRIVEN BLIND RIVETS CUT INSTALLATION TIME



You "hit-the-pin" and the rivet's in. No special tools to limit production or require maintenance, no bucking, no finishing. For blind or open applications, Southco Drive Rivets save time, reduce costs.

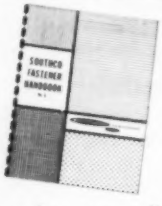
Automatic "pull-up" action assures uniform, tight grip.

Southco Rivets are made of aluminum or cadmium plated steel with cadmium plated or stainless steel pins. Diameters are from 1/8" to 1/4", grip range is from 1/16" to 3/8".

Increased widespread use is due to low installed cost and elimination of down time and maintenance associated with fasteners requiring special tools.

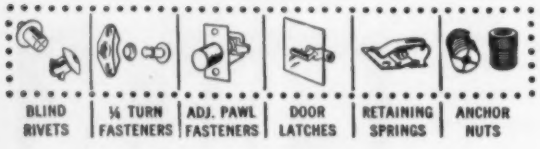
FREE!

Fastener Handbook

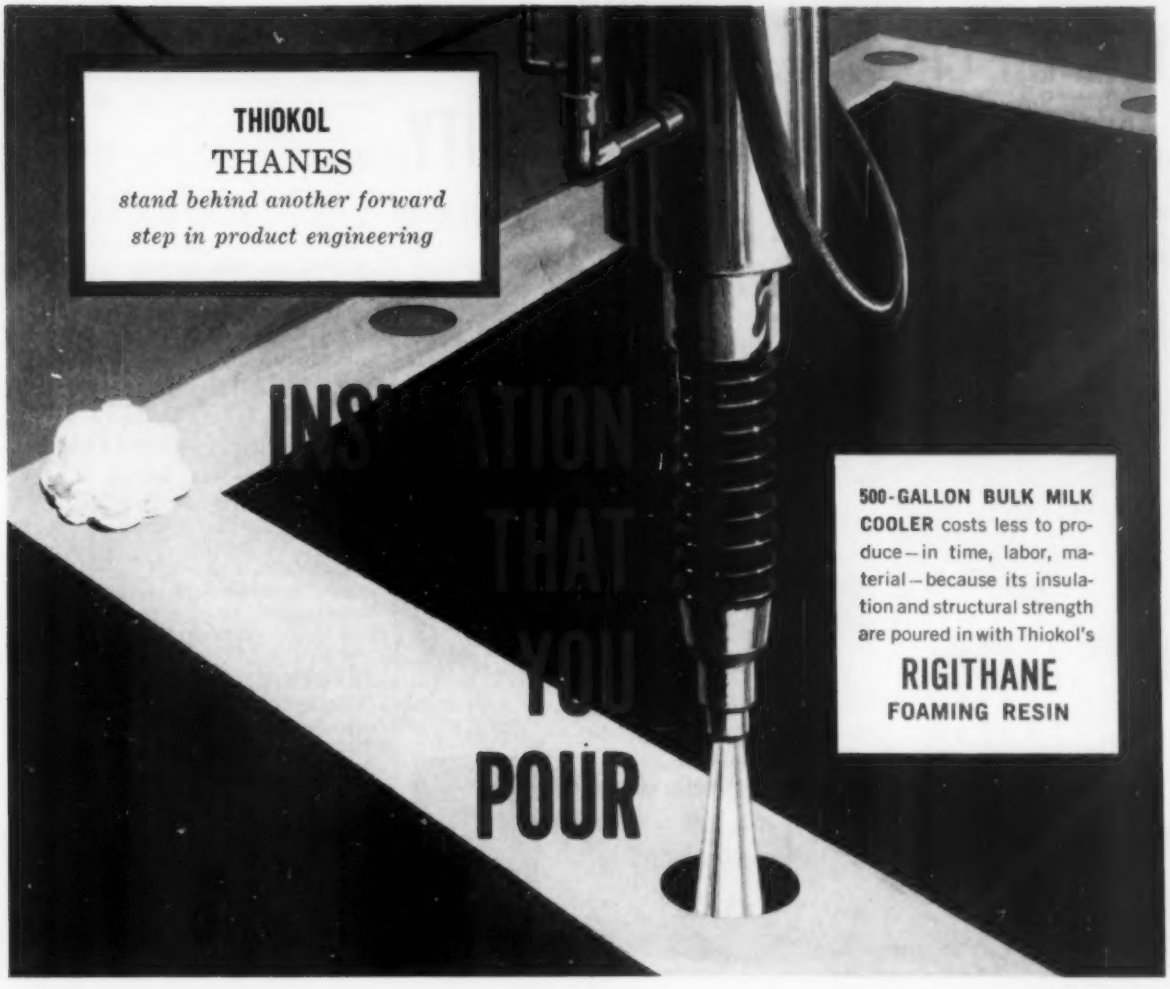


Send for your free copy of Handbook No. 9, just released. Gives complete data for designers on these and many other specialty fasteners. 48 pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.



SOUTHCO FASTENERS
©1957
LION



Adds structural strength, cuts manufacturing costs

Makers of bulk milk coolers cut time required to insulate their units from several hours to under fifteen minutes—and step up production—by using Rigithane foaming resin. They also reduce the thickness of steel and copper panels from which coolers are made because Thiokol Rigithane adheres to metal walls and provides structural strength.

Poured into wall cavities, Rigithane foaming resin delivers a layer of low density foam with low thermal conductivity and is strong enough to withstand the pressure of 500 gallons of fresh milk. Less working area is needed for production as well as less storage area for insulation inventory.

Rigithane foaming resin produces foams with a wide range of densities. They're foamed in place with manual or automatic equipment. Properties include low k factor, dimensional stability and flexural strength. Adaptable to your product? Perhaps. Use coupon to get full information.

Thiokol®
CHEMICAL CORPORATION

FOR MORE INFORMATION about Thiokol Rigithane foaming resin send coupon to Thiokol Chemical Corp., Dept. No. 41, 780 N. Clinton Ave., Trenton 7, N. J.

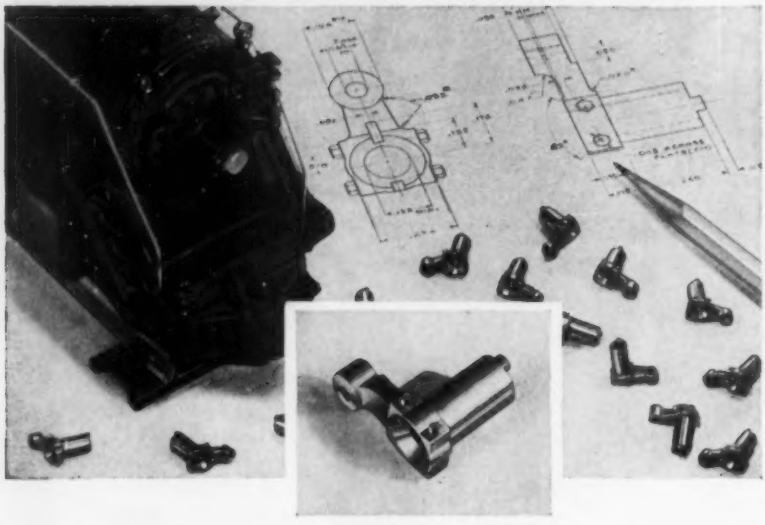
Name_____

Firm_____

Address_____

City_____ State_____

GRC DIE CASTING HELPS LIONEL ACHIEVE TINY PART AUTHENTICITY



Tiny, intricate, too costly to make in their own plant, GRC's specialized techniques made this Toy Crank economically possible

While it would seem more advantageous for manufacturers to make all parts in their own plants, some have found that a specialist can do it cheaper, faster, and sometimes even better. This Lionel toy crank is an example. GRC specialized techniques made it possible for them to produce this tiny authentic part more quickly and more economically than Lionel could themselves. Die cast in zinc alloy in a single automatic operation, the cost of the GRC crank was little more than $5.00 per thousand in lots of 500,000.

Miniature in size, intricate in shape, this crank is typical of the many small parts problems economically solved by GRC. It is typical too of the close tolerances and uniformity achieved by Gries' fully automatic methods. Whether simple or complex, quality is high—no secondary operations, no scrap loss. GRC parts leave the machines ready for immediate use.

If you have a small parts problem, need flexibility in design, write for Gries' informative bulletins on **Zinc Alloy Die Castings and Injection Molded Plastics**, or send prints for quotations. There is no minimum size. Maximum: 1¾" long, ½ oz. in zinc alloy; 1¼" long, .03 oz. in plastic.

Washer base wing and cap nuts in die cast zinc alloy now catalogued by GRC

Save inventory, assembly time, and labor, with these wide-diameter washer base nuts. Eliminate separate washers. GRC offers prompt delivery from stock in a complete range of 14 thread sizes: #6 through ⅜". Specially suited for oversize bolt holes, adjusting slots, soft surfaces.

GRC nylon nuts and screws, wire ties and clamps, now available from stock.

New nylon hex nuts in ten sizes (#2 thru 5/16"). Coil bobbins in a wide range of shapes and sizes—from ¼" diam x ⅛" long to ⅞" diam x ⅞" long—in round, square, rectangular and oval shapes. GRC's specialized techniques help you take advantage of nylon's unique properties.

Yours for the asking —GRC HANDY GUIDE TO LOW COST QUALITY FASTENERS

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.

26 Second St., New Rochelle, New York • NEw Rochelle 3-8600

Be sure to see GRC at the Design Engineering Show—Booth 1524

magnetic flowmeter. Includes specifications. Fischer & Porter Co, 38 Jacksonville Rd, Hatboro, Penna.

Circle 46, Reader Service Card

UNIVERSAL JOINTS—Catalog C4, 8 pp. Covers line of single and double universal joints, together with prices and specifications. Also contains information on engineering services, instructions for assembly and disassembly, selection data and applicable military specifications. Curtis Universal Joint Co Inc, Birnie Ave, Springfield 7, Mass.

Circle 47, Reader Service Card

STATIC O-RING PRESSURE SWITCHES—Catalog sheets 1, 2, 3 and 4; 4 pp each. Specifications, construction, characteristics and performance data on each of four models. Supplemented by cutaway views. Price sheet included. MechaniArts Associates, 401 Wyandotte St, Kansas City 5, Mo.

Circle 48, Reader Service Card

PREDESIGNED MECHANISMS, COMPONENTS—Bulletin 102-58, 6 pp. Describes line of mechanisms and components for servo and instrument fields. Specifications and dimensional drawings are included. Precision Mechanisms Corp, 577 Newbridge Ave, East Meadow, NY.

Circle 49, Reader Service Card

VARIABLE TRANSFORMERS—Bulletin 151, 8 pp. Presents operating data and dimensions on tandem assemblies and enclosed or portable transformers in addition to a description of line of variable transformers. With selection tables. Ohmite Mfg Co, 3681 Howard St, Skokie, Ill.

Circle 50, Reader Service Card

LUBRICATING DEVICES AND OILERS—Catalog 59B, 12 pp. Descriptions and dimensions of oilers, oil cups, vent tubes, tube forms, check valves, tube and special assemblies. Also notes facilities for tube forming. Eynon-Dakin Co, 9900 Freeland, Detroit 27.

Circle 51, Reader Service Card

FINE-PITCH MASTER SPUR GEARS—Stock list, 8 pp. Diametral pitch, pitch diameter, face width and bore are indicated for each gear. Charts show required AGMA tolerances, compared with spline tolerances, and AGMA recommended rolling pressures. Invo Spline Inc, 2357 E Nine Mile Rd, PO Box 25, Hazel Park, Mich.

Circle 52, Reader Service Card

SINGLE-DECADE COUNTING UNITS—Bulletin, 4 pp. Construction and electrical data is supplemented with descrip-

(Continued on page 103)

EASY AS IT LOOKS!

NEW ADD-A-UNIT MANIFOLDS WITH ELECTRICAL PLUG-INS SIMPLIFY MULTIPLE AIR INSTALLATIONS

Here's an important air valve "first"! We have now engineered our MAC Dual-Seal valves with optional *add-a-unit manifold bases.* Two to ten of the bases can be combined quickly and easily—giving you a single, compact, inexpensive manifold to suit your exact requirements, take up far less space.

As the picture shows, the manifold forms common inlet, common exhaust and common conduit channels. The side and bottom cylinder ports come in either ⅜" or ½" sizes. And if you wish to use more than one pressure, "add-a-units" let you isolate valves and feed pressure from each end. Bottom inlet ports are available, too.

Now, we also have simplified valve wiring. Each manifold base has female receptacles (see picture) with attached plug-in leads for quick, positive connections. The valve body has male terminals pre-wired to the MACsolenoid. To connect, just plug in the body to the base. It's as easy as plugging in a lamp . . . and it lets you replace a valve without any additional wiring. MAC design also offers standardized bodies, bases and solenoids (single or double); circular air-flow; and the valve is J.I.C. specified. Put Dual-Seal efficiency in your air operations now! Write for complete information or phone your MAC representative.

A. D. Lumley

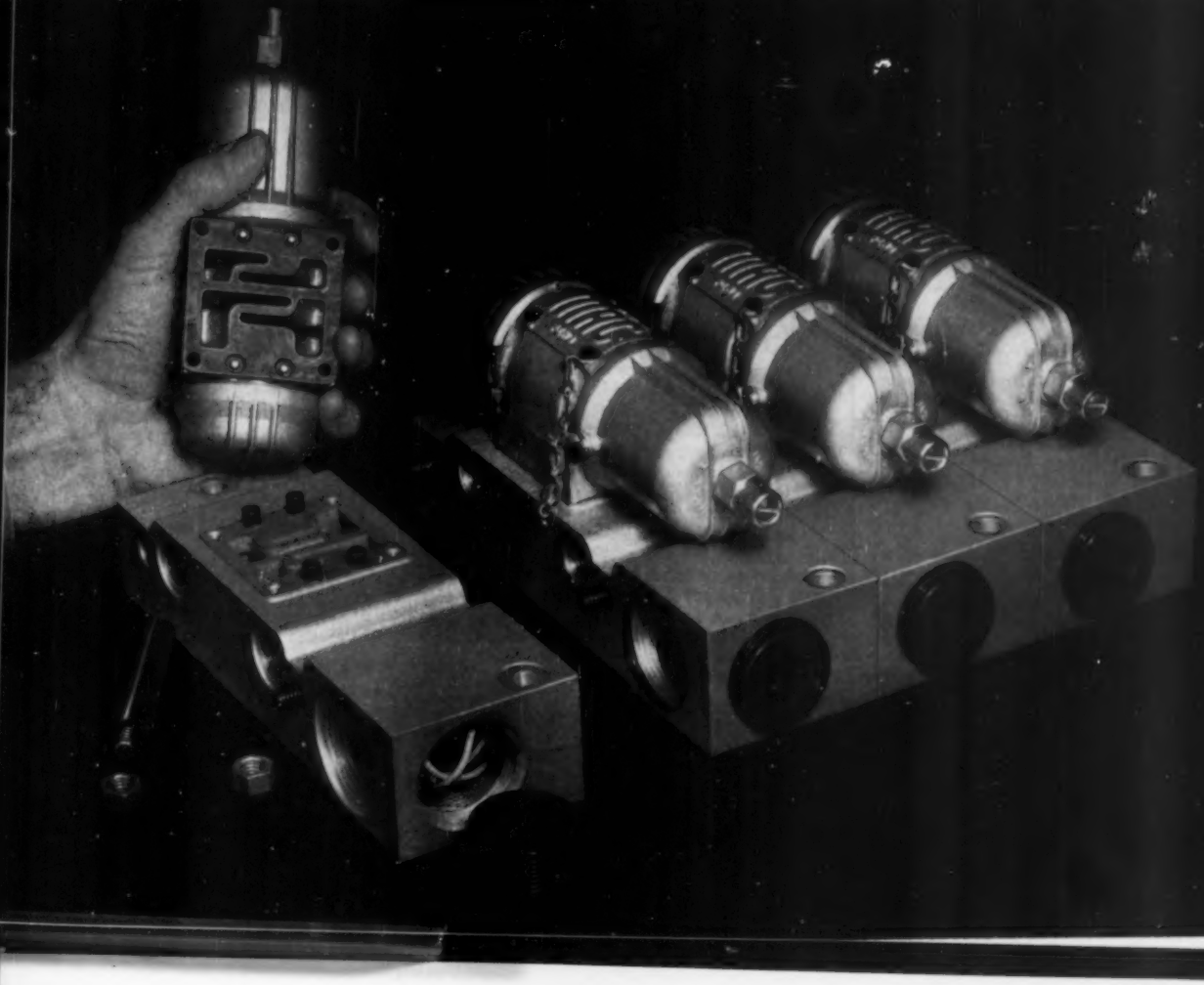
PRESIDENT

MECHANICAL AIR CONTROLS, INC.

10030 Capital, Oak Park, Detroit 37, Michigan

Export Representative: Ad Auriema, 85 Broad St., NYC 4

MAC



News about R&A SINCE 1913 **Adhesives**

FOR ALL METALS AND ALL PLASTICS

This "100%-solids" adhesive flows like a heavy-bodied motor oil

TECHNICAL DATA ON

Bond*master*® M648T

A free-flowing, high strength, room-temperature-curing, 100%-reactive, two-component, formulated epoxy adhesive designed for bonding all metals and other rigid materials (such as glass, ceramics, plastics, plastic foams, and structural laminates) to themselves and to each other.

BOND CHARACTERISTICS

Fully cured bonds exhibit minimal shrinkage, are electrical insulators, and provide excellent resistance to weather, galvanic action, and most chemicals, acids, and alkalies.

APPLICATION

Mixed BONDMASTER M648T may be applied with trowel, spatula, knife, roller, brush, etc. Apply enough *mixed* BONDMASTER 648T to fill all cavities and depressions in both surfaces *and* to leave about 4 additional mils of adhesive on each side. Press together firmly to establish and maintain intimate contact, and cure. Pressure is not required during cure.

SPECIFICATIONS

VISCOSITY (mixed): about 10,000 cps. COLOR: clear, pale amber. BASE: modified epoxy. SOLIDS: 100%. HARDENERS: CH-8 for balance of all properties; CH-16 for best shock and peel strengths. WEIGHT PER GALLON: about 10 lbs. STORAGE: 1 year, unmixed. CONTAINERS: 1-gal. cans; 5-gal. pails; 55-gal. drums.

R&A SINCE 1913

RUBBER & ASBESTOS
CORPORATION
235 BELLEVILLE AVENUE
BLOOMFIELD, NEW JERSEY

Don't let the "100%-solids" term confuse you . . . this modified epoxy adhesive is a free-flowing liquid!

BONDMASTER M648T ("T" for "thin") exhibits all the smooth mixing characteristics and ease of handling of a 10,000 cps fluid—can be applied by brush, spatula, roller, spreader, or similar conventional equipment.

As with all BONDMASTER formulated epoxy adhesives, M648T yields high strength bonds on all rigid metals and just about any plastic or plastic laminate. In addition, its lower viscosity makes it ideally suited for work on flexible plastic sheets (like bondable Teflon) or fragile cells of rigid plastic foams (like Styrofoam) as well as on thin metallic foils of all types.

100% REACTIVE

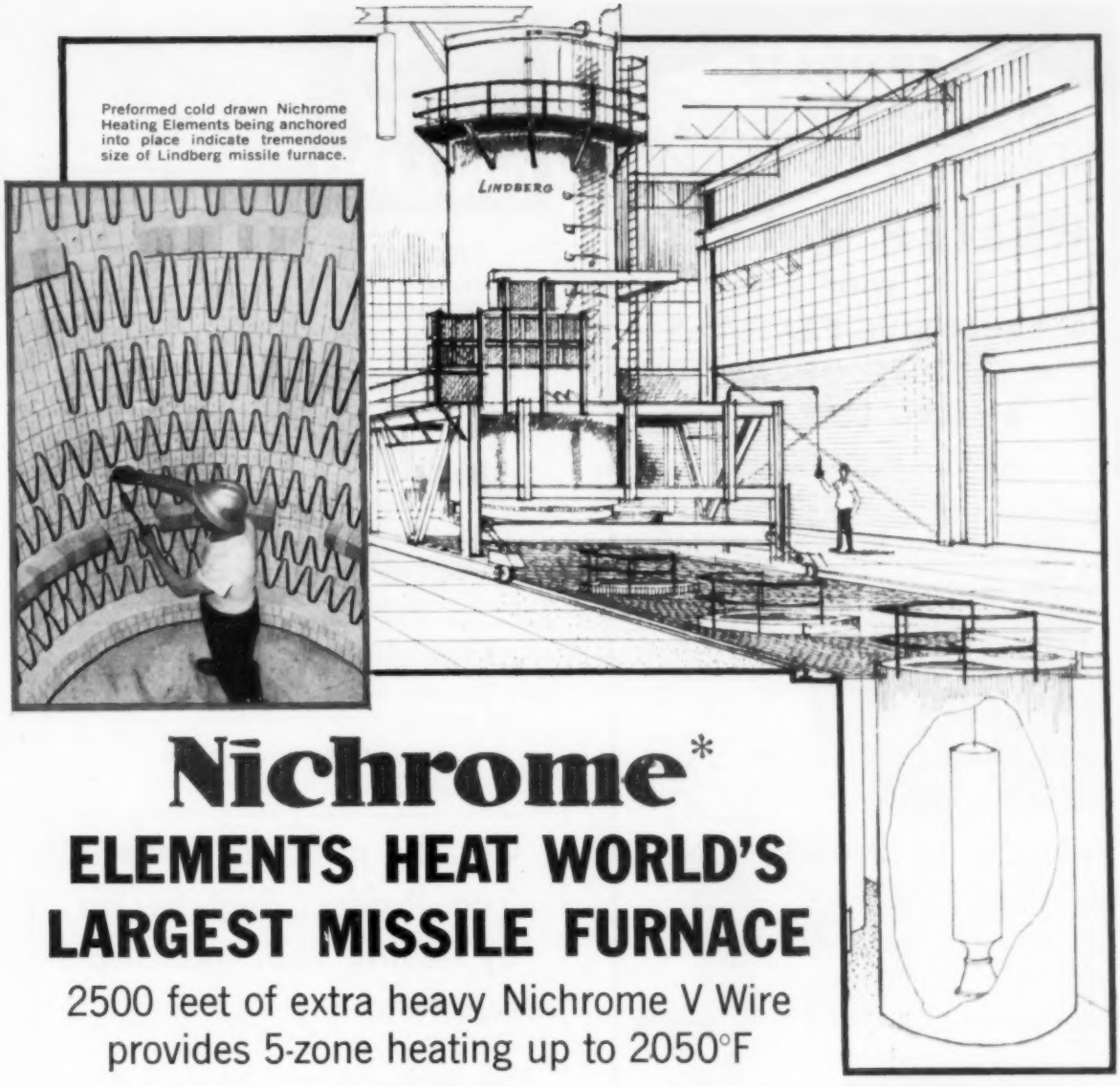
The glue line thickness you put down won't shrink, either during the cure or after it . . . this formulation is 100% reactive. (There is no wait for solvent evaporation either.) Mere contact pressure is sufficient.

CURES AT ROOM TEMPERATURE

A bond that's strong enough to permit handling of your assembly develops at room temperature in from 4 to 6 hours; about 85% of maximum strength in less than one day. Alternately, if you can heat-cure, you can reach full strength far more rapidly—in as little as 10 minutes at 250°F., for example.

WRITE FOR FURTHER DATA

Write for Technical Data Sheet describing this 100%-reactive, free-flowing liquid epoxy adhesive formulation. We will be glad to send a free evaluation sample as well if you will describe your bonding problem in detail.



Preformed cold drawn Nichrome Heating Elements being anchored into place indicate tremendous size of Lindberg missile furnace.

Nichrome*

ELEMENTS HEAT WORLD'S LARGEST MISSILE FURNACE

2500 feet of extra heavy Nichrome V Wire provides 5-zone heating up to 2050°F

This giant 500 KW gantry type Lindberg† hardening furnace is the newest and largest ever built to meet the most exacting heat treating requirements of today's, and tomorrow's, missile metals. It accommodates an effective work load nearly 7 ft. in diameter and 24 ft. long.

Now in operation at Lindberg Steel Treating Company's Melrose Park Plant, the controlled atmosphere installation is both bottom loading and bottom quenching. The 19′ by 57′ pit—28′ deep, beneath the towering electrically heated furnace, houses the loading station, 2 quench tanks (atmosphere and salt) and water wash tank. Work loads pass from furnace to quench through an airtight seal, permitting complete control and precise duplication of atmospheres and treating cycles.

In the hardening furnace there are five control zones which operate between 250°F and 2050°F. Saturable core reactors automatically vary the voltage to the Nichrome*V heating elements between 2.2 and 220 volts, depending on temperature and load.

The selection of Nichrome V by Lindberg to supply reliable and closely controlled heat and temperature in this furnace is further evidence of the confidence that industrial leaders have in the quality and performance of Driver-Harris high-nickel alloys. Why not benefit from their experience. Tell us about your requirements. *T.M. Reg. U.S. Pat. Off. †Lindberg Engineering Company

DRIVER-HARRIS* COMPANY

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

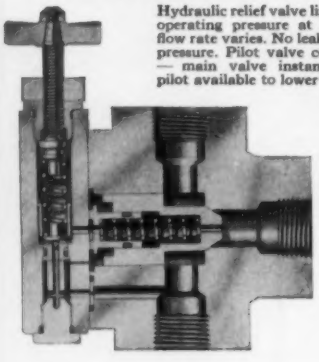
MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

SPECIAL PURPOSE ALLOYS SINCE 1888 — TRADE MARK REG. U.S. PAT. OFF.

REPUBLIC VALVES
FOR EVERY INDUSTRY

RELIEF VALVES
WITH
- EXCLUSIVE FEATURES
- SMOOTH OPERATION
- LONG LIFE

PILOT-OPERATED RELIEF VALVE

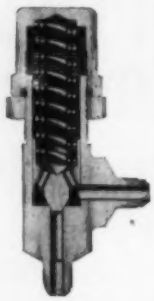


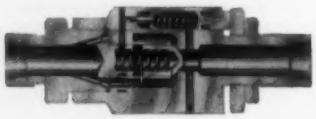
Hydraulic relief valve limits system's maximum operating pressure at constant level, though flow rate varies. No leakage loss below cracking pressure. Pilot valve controls pressure setting — main valve instantly conforms. Remote pilot available to lower setting of integral pilot control. 3 pressure ranges: 50 to 1200 psi; 1000 to 3000 psi; 2500 to 5000 psi. 50,000 tensile semi-steel body standard; aluminum alloy to order. FMP or str. thread gasket seal bosses, ¼" to 1¼". Panel mounting bosses.

Modified units available as Sequence Operating Valves; and as Unloading Valves for clamping or other two-pressure applications.

POPPET TYPE RELIEF VALVE

Smoothly sliding poppet, seated by a stainless steel compression spring is the simple design of this rugged unit. External adjustment. Two types of sealing elements available. Soft seal poppets for air, gas, and liquids, with no leakage; stainless steel poppet for general hydraulic applications. Other poppet materials available for special chemical services. Eleven pressure ranges to 2750 psi, ⅛" to ¾" pipe, tubing, internal straight threading. 250°F std — specials to 400°F. Aluminum alloy, brass, or stainless steel.





ADJUSTABLE IN-LINE RELIEF VALVE

External relief adjustment without breaking line is the feature of this 5000 psi relief valve. Limits hydraulic system's maximum pressure at constant level, with minimum rise above cracking pressure. Turning locknut on body varies relief pressure adjustment spring in pilot valve. Free reverse flow. 2 pressure ranges: 50 to 2500 psi; 2000 to 5000 psi. Stainless steel body with hydraulic o-ring, -65° to 160°F standard. Packings for other fluids, and higher temperatures available. Flare or flareless tube connections ½" and ¾".

Distributors in principal cities coast to coast

CHECK RELIEF SELECTOR GLOBE NEEDLE PLUG

RM REPUBLIC MANUFACTURING CO.
15655 BROOKPARK ROAD • CLEVELAND 35, OHIO

AT STANDARD WE'RE IN IT
UP TO OUR EARS!

FASTER — CUTS MACHINING TIME
PRODUCES A FINER FINISH
ELIMINATES HEAT-DISTORTION
REDUCES WHEEL COST UP TO 90%

IN THIS NEW FIELD, STANDARD SUPER PRECISION SPINDLES ARE FINISHING DOZENS OF HARD METALS!

AIRCRAFT PARTS (Internal and External Grinding)

DENTAL BURR BITS

HYPODERMIC NEEDLES

Write for Catalog today.

A leading designer in this NEW field says: "A solid, true and smooth running spindle is essential for good results . . . "

THAT'S WHERE STANDARD SUPER PRECISION SPINDLES COME IN . . . Standard of the industry for accuracy, vibrationless operation and long life.

Write today for full information on THE ELECTROLYTIC GRINDING PROBLEMS WE'VE HELPED SOLVE . . . we'll work with you on yours. 75 to 3000 Amperes.

the STANDARD electrical tool co.
PRECISION SPINDLE DIVISION
2601 RIVER RD. CINCINNATI 4, OHIO

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Product Engineering
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330 W. 42nd St.
New York 36, N.Y.

tion of various auxiliary contacts and executions that make possible varied applications. Some typical schematics are given. Landis & Gyr Inc, 45 W 45th St, New York 36.

Circle 53, Reader Service Card

DIESEL ENGINES—Brochure, 8 pp. Tells how diesels work and compares them to gasoline engines on such points as work-producing ability, economy of operation and life span. Detroit Diesel Engine Div, General Motors Corp, Detroit 28.

Circle 54, Reader Service Card

SERVOVALVE—Catalog 150, 6 pp. Describes operating principles, design features and performance characteristics of pressure-control servovalves. With schematic diagram, cutaway diagram and performance curves. Moog Valve Co Inc, East Aurora, NY.

Circle 55, Reader Service Card

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

ADHESIVES, SEALERS AND COATINGS—Brochure, 20 pp. Discusses considerations in selecting right adhesive. Adhesives, sealers and coatings are listed within classifications, including information on typical uses, characteristics, application and bonding method. Armstrong Corp Co, Lancaster, Penna.

SELECTING A STRAIN GAGE—Article reprint, 24 pp. Compares characteristics of resistance strain gage made by eight US manufacturers. Specifies selection criteria for various properties under different operating conditions. Reprinted from Strain Gage Readings, a company publication. Stein Engineering Services, 5602 E Monte Rosa, Phoenix, Ariz.

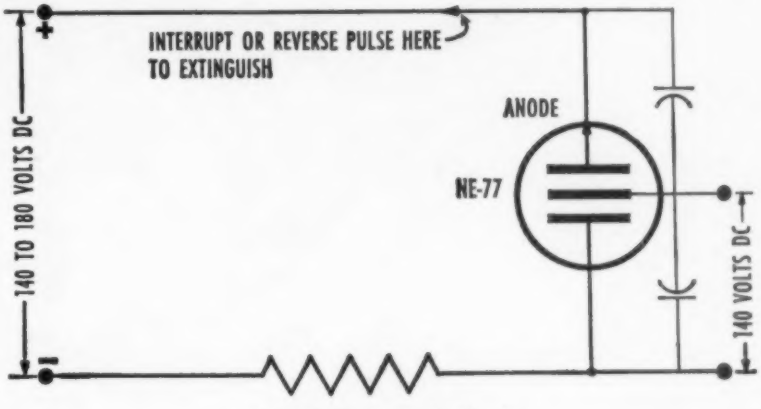
STOCK EXTRUSION DIES—Catalog, 179 pp. Contains full-scale, dimensioned diagrams of several thousand dies of extruded mill products made of magnesium and aluminum and available from stock. Dies pictured include rods, bars, tubes, structurals, solid shapes, hollow and semi-hollow shapes. White Metal Rolling & Stamping Corp, 92 Moultrie St, Brooklyn 2, NY.

SERVOMOTORS, MOTOR GENERATORS AND SYNCHROS—Manual (5th edition), 48 pp. Stated purpose of reference is to clarify terms, applications and component behavior. Covers principles of servomotors, tachometer generators, motor generators and synchros and their application to precision instruments. Kearfott Co Inc, 1500 Main Ave, Clifton, NJ.

For triggering and switching . . .

new 3-electrode G-E Glow Lamp

with 3 terminals



G-E NE-77 in Basic Circuit

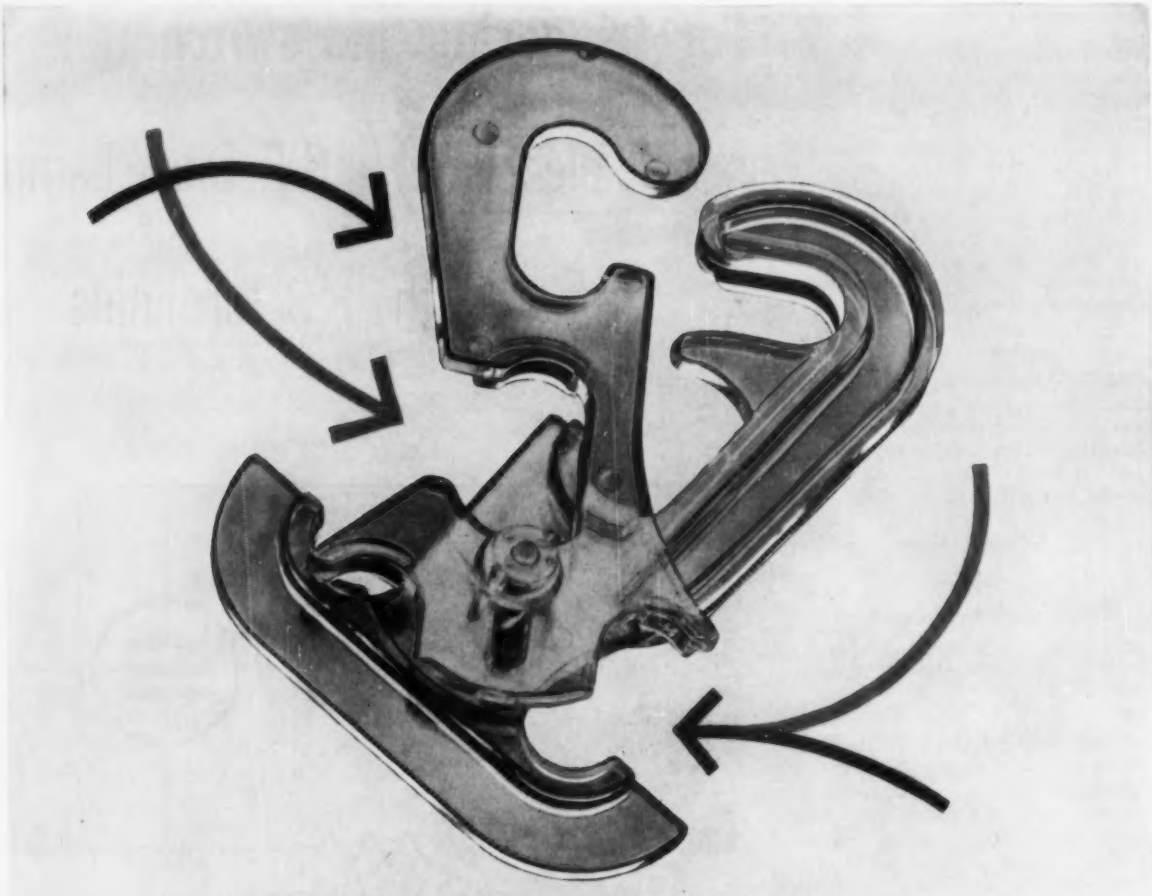
The new G-E Glow Lamp NE-77 contains three electrodes instead of two, with connections being made by means of three wire terminals. It requires no heater current and has the same shape and bulb dimensions as the familiar NE-2.

To start the lamp with 140 to 180 volts d.c. across the outer electrodes, a pulse of 140 volts must be applied to the center electrode trigger. Without using the trigger, more than 200 volts would have to be applied across the power circuit before the lamp would accidentally break down. As little as 80 microamperes in the trigger circuit will operate the lamp.

Once started, the new NE-77 will continue to conduct until the circuit is interrupted or a reverse pulse is introduced in the power circuit. For further information, write for the free engineering data sheet #3-8161. General Electric Co., Miniature Lamp Dept., Nela Park, Cleveland 12, O.

Progress Is Our Most Important Product

GENERAL ELECTRIC



This molded plastic part hangs up a record 60% savings

Could be abstract art. Actually, it's a brand new molded plastic device for hanging both low and high voltage power cables—saves up to 60% of the cost of running power through heavily timbered areas. In designing this 15¾ oz. 4-part suspension clamp for injection molding, we worked with customer engineers—adapting their design to custom molding requirements. The selection of molding material—Methyl Methacrylate—assured the right electrical and physical properties, and the ability to withstand all types of weather. This is just *one* angle of every plastic molding job. Because we mold all types of materials and offer full range (small to large) compression, injection and transfer molding facilities, we're free to make unbiased recommendations . . . to provide the material and method of most value to you. For more information, call or write.

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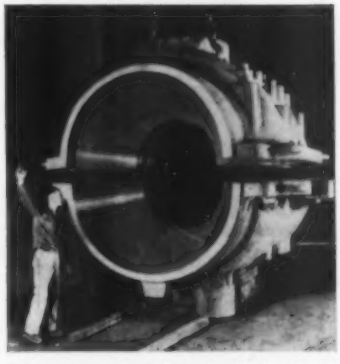
This practical design analysis, a feature of Blaw-Knox Steel Casting Service, is of invaluable assistance to designers and manufacturers. And because Blaw-Knox, itself, is one of the world's leading manufacturers of rolling mills and industrial machines, its steel foundrymen, from patternmaker to shipper, keep end-use requirements in mind every step of the way.

If you are a designer or manufacturer of a product using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like to send you a copy of our brochure which details the complete Blaw-Knox Steel Casting Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.



This upper and lower cylinder blade ring for a steam turbine was cast and machined by Blaw-Knox. Weight—55,000 pounds per half.

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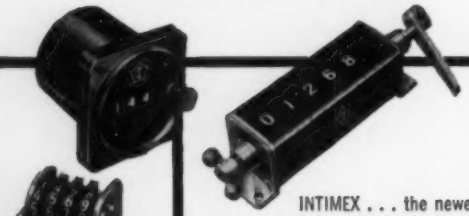

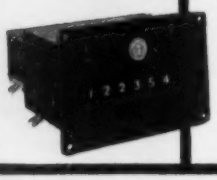

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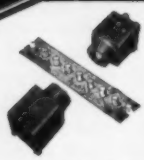

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DESIGN ABSTRACTS

High-temperature Gear Operation

Testing of lubricants, materials and various gear designs, begun in Aug 1956, is described here. Data on oxidation stability, thermal stability, fatigue and other findings are included.

"Investigation of Factors Affecting High-temperature Gear Operation," E E Shipley, General Electric Co, Lubrication Engineering, March 1959, 84 E Randolph St, Chicago 1.

IRE National Convention, March 23-26

For copies of papers: 1 E 79th St, New York 21

Adaptive Control Systems

Attempt is made to evolve basic philosophy for adaptive control systems. Two systems are discussed, one stable and one unstable. Results are presented in graphic form. This paper* was one of five in a session devoted to the theory and concept of control devices able to learn and improve their performance through experience. The other papers were by J. G. Truxal (IRE paper 1.1), M. Freimar (1.2), Hsieh and C. T. Leondes (1.3), P. H. Ellis (1.5).

** "On Adaptive Control Systems," Ludwig Braun Jr, Brooklyn Polytechnical Institute, IRE paper 1.4.*

Engineering Writing and Speech

Among the five papers presented on this topic was "Using the Psychological Approach in Scientific Writing," by J L Kent, Datex Corp, IRE paper 3.1. Tells how and why the writer of technical papers should apply professional writing techniques.

"A Self-improvement Program for Engineering Writers," by A H Cross, Raytheon Mfg Co, IRE paper 3.3, proposes a program of regular attention to developing the skills needed to turn out better technical papers and reports.

"Read Your Speech," E W Still, General Electric Co, IRE 3.4, tells how to prepare and deliver a paper so it won't sound like it is being read.

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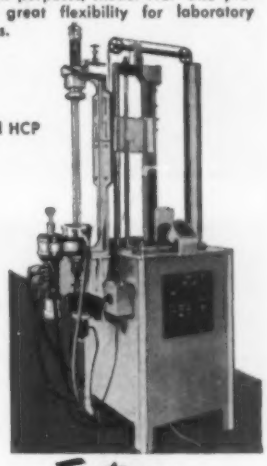
FLOATING ZONE UNIT FOR METAL REFINING AND CRYSTAL GROWING

A new floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacumm or inert gas. Designed primarily for production purposes, Model HCP also provides great flexibility for laboratory studies.

Model HCP



Features

- A smooth, positive mechanical drive system with continuously variable up, down and rotational speeds, all independently controlled.
- An arrangement to rapidly center the process bar within a straight walled quartz tube supported between gas-tight, water-cooled end plates. Placement of the quartz tube is rather simple and adapters can be used to accomodate larger diameter tubes for larger process bars.
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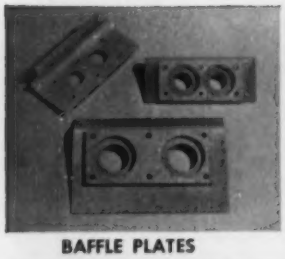
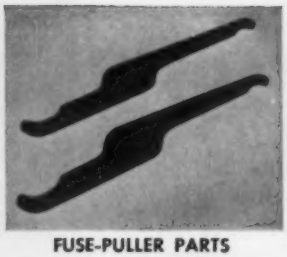


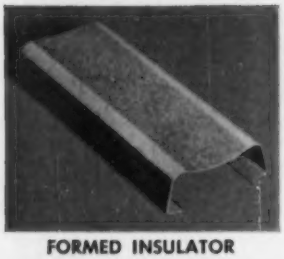
BAFFLE PLATES



FUSE-PULLER PARTS

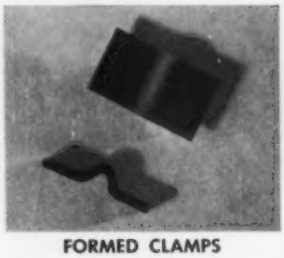
DISCS

GASKETS



FORMED INSULATOR

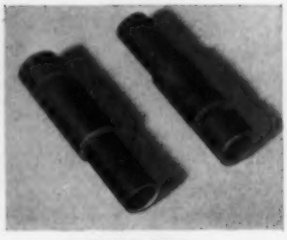
SCREW



FORMED CLAMPS

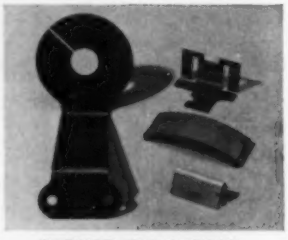
INSULATING BUSHING

SPOOL

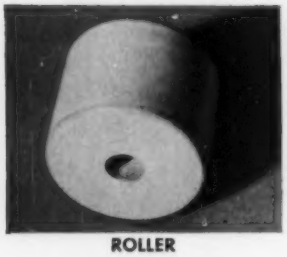


CABLE GRIP

BUSHING



FORMED INSULATORS



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higher speeds

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extended bearing wear

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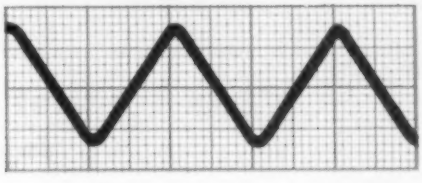
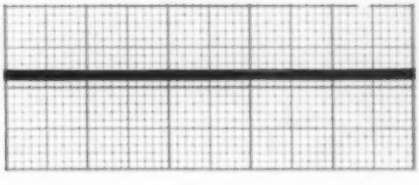
Genuine RZEPPA Joints are made exclusively by THE GEAR GRINDING MACHINE CO.



ORDINARY CROSS OR PIN UNIVERSAL JOINT — Mathematics and geometry prove this joint changes velocity of the driven shaft with two high points and two low points per complete revolution. This fluctuating torque action causes vibration and wear throughout entire driving mechanism.



CONSTANT VELOCITY JOINT — This RZEPPA design joint *always* transmits smooth torque even at unbalanced angles. Such smooth torque action results from ball bearings applying power in a plane that bisects both shaft axes.

NOW! Higher Hydraulic Pressures Possible with NEW ANCHOR "SUPER-SPIRAL" HOSE

OIL RESISTANT NEOPRENE INNER TUBE
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The lack of dependable, extra high pressure hose has hampered designers wishing to increase pressures used in hydraulic equipment.

Anchor's new "SUPER-SPIRAL" Hose removes these limitations and offers the hydraulic engineer a new maximum pressure range. It is finding wide usage in the replacement of old style braid hose to obtain greatly extended service life.

It is available in sizes from 3/16" I.D. to 1½" I.D. with either 4 plies or 6 plies of all spirally wound heavy wire reinforcement, with no crossed wires to fatigue, break or weaken hose.

- **Maximum Working Pressures:**
  6 Ply—12,500 psi, 3/16" I.D. to 3,000 psi, 1½" I.D.
  4 Ply—10,000 psi, 3/16" I.D. to 2,500 psi, 1½" I.D.
- **Heavy .022" dia. wire reinforcement.**
- **All spirally wound—no braid, with its crossed wires that lead to wire fatigue.**

Andy Anchor says: A special data sheet with all specifications of Anchor's new SUPER-SPIRAL HOSE will be sent on request.

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NEW BOOKS

Fundamentals of Transistors

LEONARD KRUGMAN. John F Rider Inc, 116 W 14th St, New York 11. Paperbound, 5½ x 8½, 168 pp. $3.50.

Intended as a practical text for technicians and amateurs, this book can serve as an introduction to fundamental characteristics for the mechanical engineer—particularly if he has been away from electronics or advanced mathematics for some time. Advanced physical and mathematical concepts are purposely avoided. This revised edition has been brought up to date by the addition of the surface barrier, intrinsic, drift, avalanche, and spacistor transistors, and the inclusion of review questions at the end of each chapter. Basic circuit configurations are discussed in a chapter on grounded-base transistor and another chapter on grounded-emitter and grounded-collector transistors. Final three chapters concern applications: amplifiers, oscillators, high frequency circuits.

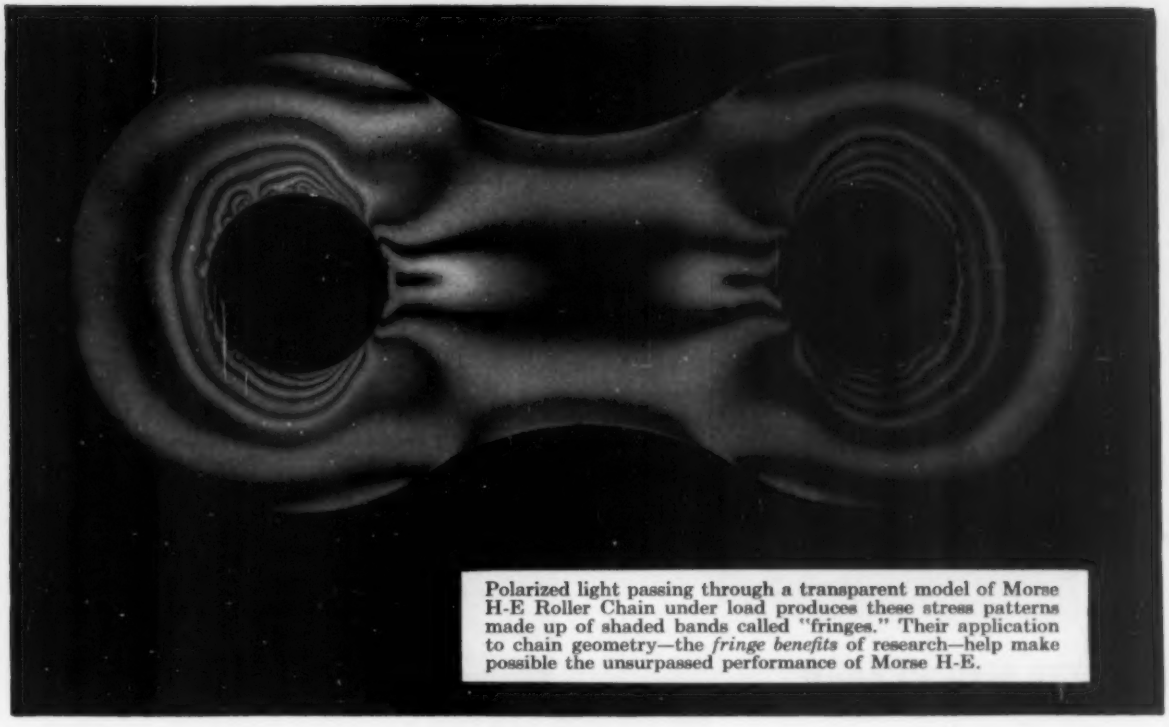
Electronic Engineer's Reference Book

L E C HUGHES. Macmillan Co, 60 Fifth Ave, New York 11. 5 x 7½, 1311 pp. $18.

Preliminary pages include two articles on the history of electronics. The body of the text has been divided into nine main parts, subdivided into up to nine sections each. Some important electronic topics have been excluded because they have been written about previously. This includes much on radar, audio, television, telecommunications, wave-filters, and all service equipment.

"Fundamentals" includes general background information, the ionosphere, information and communication theories, spectral lines, isotopes, nuclear power and sources of radiation. "Radiations" covers infrared and ultraviolet sources, including applications for lighting, photoelectrics, photocopying, radiofrequency, heating of metals, wood, glue, and dielectric heating of plastics. "Electrics" covers conduction, transmission, eletrolytics, batteries, pH, electrophoresis, electrostatics, ferroelectrics, piezoelectrics, high-voltage machines and transform-

(Continued on page 113)



Polarized light passing through a transparent model of Morse H-E Roller Chain under load produces these stress patterns made up of shaded bands called "fringes." Their application to chain geometry—the *fringe benefits* of research—help make possible the unsurpassed performance of Morse H-E.

Photoelastic stress study shows . . .

"FRINGE" BENEFITS MAKE MORSE H-E CHAIN LAST UP TO 5 TIMES LONGER!

Improved design . . . special mechanical and metallurgical processes give Morse H-E a 95% higher endurance limit

"Fringes"—the shaded bands which make up photoelastic patterns—show the intensity and distribution of stresses set up in a chain link-plate model under load. Morse engineers first use this knowledge to improve chain geometry. Then Morse production engineers apply advanced mechanical and metallurgical processes to side plates. Result: Morse High-Endurance Roller Chain, with up to 500% longer life under repeated heavy loadings.

Special treatment makes Morse H-E Chain cost about 10% more. Yet it pays for itself many times over in annual savings on replacement costs, lost production time and wasted man-hours.

For full information on research-developed Morse High-Endurance Roller Chain, write: Morse Chain Company, Dept. 4-49, Ithaca, N. Y. Export Sales: Borg-Warner International, Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.

ORDINARY CHAIN BREAKS when the side plate tires from repetitive loading and unloading during the cycle around the sprockets. But Morse H-E Roller Chain has a 95% higher endurance limit . . . outlasts ordinary chain by up to 5 to 1 under repeated loading.

MORSE

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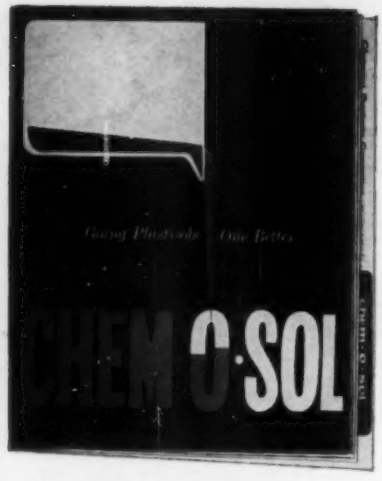
FROM PLASTISOL HEADQUARTERS



FACTS YOU NEED TO KNOW

about plastisols

This brochure brings you up-to-date on plastisols. A new edition of the definitive work in the field of polyvinyl dispersions, "*Going Plastisols One Better*—**chem-o-sol**", answers such questions as these:

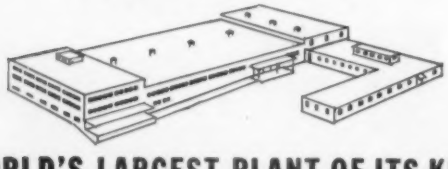
- **What are plastisols?**
- **How are plastisols applied?**
- **How can we use plastisols?**
- **How have plastisols cut assembly costs?**
- **What important properties of plastisols make them useful to industry?**
- **What future uses for plastisols can be anticipated now?**

The booklet shows many ways of improving a product with **chem-o-sol** . . . how to simplify production . . . why Chemical Products Corporation, with its pioneering experience in plastisols, its vast facilities for research and production, is your best source of supply.

Get the full story on this versatile coating and molding material for industry. For your free copy of the new **chem-o-sol** brochure, circle the reply card or write Chemical Products Corporation, Dept. PE-4, East Providence, R. I.

Going Plastisols One Better

chem·o·sol



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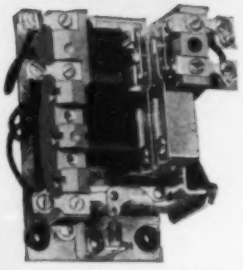

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ers. "Valves" includes tables and diagrams of valves and valve bases, four articles on design of pentode receiving-type valves, measurements, cathode-ray tubes, diodes and transistors. "Materials" treats permanent magnetic amplifiers, metals, nonmetals, mechanics, gages, springs, mechanical constants and screw threads. "Vibrations" includes ultrasonics, vibration therapy, sound radiation, acoustic measurements and electronic music. "Computers" has basic apparatus, office computing machines, full program and operation of machines. "Automatics" discusses electronics in automation, automation in plants, unit automation and printed circuits. "Miscellaneous" discusses mathematics, mathematical tables, safety, education, nomenclature and selected lists of official bodies and publications. There is a full index.

Each of the articles has been written by one of 50 experts who is working in or has worked in his field.

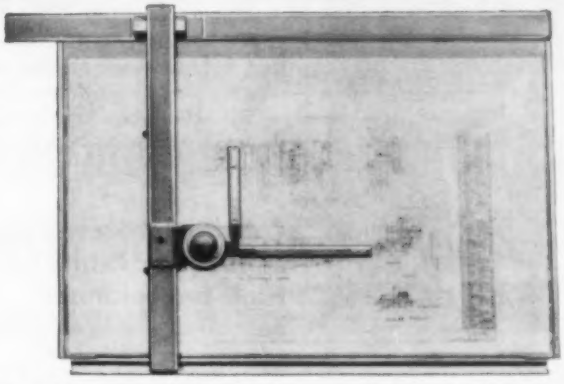
Design Data for O-Rings and Similar Elastic Seals

FRANK W TIPTON, GEORGE E TREPUS, JAMES J HILL, ETHEL L SCHIAVON, CHESTER J DEZEIH. Office of Technical Services, Dept of Commerce, Washington 25, D C. 8½ x 11, 95 pp. $2.25.

This is a continuation of a study to gain knowledge of design data for O-rings and similar elastomeric seals. The literature survey on O-rings and seal design has been continued and enlarged to include the effects of irradiation and extreme low temperature on seal design. Low-temperature tests, relaxation- and volume-change tests, screening tests, and functional tests have been conducted.

(Continued on page 114)

DRAFTING TRENDS



The Universal Tracmaster drafting machine, currently being introduced by POST, is perfectly balanced for all board angles without protruding counterweights. The Tracmaster features extreme parallel accuracy, offering featherlight responses for easy operation, with the same overarm protractor head used on the famed Universal Boardmaster drafting machine.

Advance information about outstanding new track drafting machine

Over recent years, drafting techniques have progressed to machines and boards designed for variable angle drawing . . . from near-horizontal to high angle vertical positions. There has been a growing need for more efficient tables to minimize draftsmen's fatigue . . . for drafting equipment suitable for long traversing and large layout drawings . . . as well as for drafting machines suitable for ultra-precise detail work.

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An outstanding *exclusive* feature of the Tracmaster is the inclusion of track graduation, *in addition* to all the usual angular and dimensional measurements. On each track, numbered graduations are provided at precise 10-inch intervals —for quick, easy reckoning. In effect, these graduations divide the entire drawing area into a 10-inch grid pattern—useful for establishing reference points or measuring and drawing long lines—with no cumulative error due to repeated scale extensions.

The extremely rigid horizontal beam rail you see across the top of the Tracmaster is mounted to the board by two brackets. Once mounted, there is *never* a need for adjustment. The machined beams *always* stay straight.

Efficient design conserves space

If space is a problem, you'll find the Tracmaster a perfect answer. There are *no* protruding arms or weights in the back, so the machine can be used close to walls or near other tables. You can actually put more tables in a given area using the Tracmaster on a Hamilton Auto Shift or L-Angle Table than you can with any other drafting combination. In fact, in all POST's years of experience in working to serve draftsmen, engineers and designers, this combination of the Universal Tracmaster with modern Hamilton equipment offers by far the best opportunity to materially improve drafting efficiency.

The Tracmaster's protractor head is the same as the protractor used on the famous Universal Boardmaster drafting machine. It provides full 360° visibility; has a powerful, positive and full circle baseline setting; and a ball bearing indexing head. With this protractor head you quickly, conveniently and accurately lock your scales to any position.

For more information on the Tracmaster drafting machine, write today to Frederick Post Company, 3664 N. Avondale Avenue, Chicago 18, Illinois.

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The functional tests include pulsed annulus tests with various groove configurations and reciprocating shaft tests with and without different types of back-ups at room temperature and at elevated temperatures.

The authors note that no over-all relationship between physical property values and seal efficiency has been found. However, certain physical properties appear to be important to seal life for specific seal conditions.

Chemical Processes as Methods of Achieving High Temperatures

DAVID ALTMAN. PB 131549, Office of Technical Services, US Dept of Commerce, Washington 25, DC. Paperbound, 8½ x 11, 20 pp. 75¢.

The most critical property for high-temperature flames is the bond energy between atoms. In a study of chemical reactions to determine those capable of yielding very high temperatures it was found that the N-N and C-O bonds yield the most energy. But flame temperature also depends on gas pressure, and the effect of this variable is discussed. Report includes charts and graphs.

Preferred Numbers

Standard Z17.1—1958, American Standards Assn Inc, 70 E. 45th St, New York 17. 8½ x 11, 22 pp. $1.

In the absence of any guidance as to what values should be used, the sizes chosen by different designers will probably show a wide spread. As a result, unfortunately, the trend is away from such uniformity of sizes as would be advantageous as well as practicable. The adoption of a series of preferred numbers to be used by all designers, as the term indicates, in preference to other sizes, tends to unify sizes chosen by different designers and thus to create that uniformity and consequent interchangeability which often are indispensable to successful standardization work.

High-temperature Solid Dry-film Lubricants

MELVIN T LAVIK. PB-131986, Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 11, 25 pp. 75¢.

The report (WADC 57-455) covers the development and evaluation of a dry-lubrication test machine and the testing of several dry-film lubricants. This was done to meet the very high temperature and pressure requirements (up to 800 F and 50,000 psi) currently placed on lubricants in the aircraft industry.

Several commercial dry-film lubricants and also some materials prepared at the Midwest Research Institute were investigated for both friction coefficient and wear life at the various temperatures and pressures available with the test machine. In general, the materials worked with, while effecting reasonable lubrication, did not exhibit the wear life which is desired.

Data-reduction Catalog

A Catalog of Devices Useful in Automatic Data Reduction by ROBERT S HOLLITCH and ALBERT K HAWKES. WADC Technical Report 54-519, Part II, First Revision. Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. Paperbound, 8½ x 11, 191 pp. $5.

Products of over 50 manufacturers are listed and fully described in this catalog. Emphasis is on analog-to-digital converters, digital readout devices, digital plotters and miscellaneous digital devices. In addition to all significant technical information, catalog includes manufacturer's name and address, price and photos.

A Survey of Hydrodynamic and Hydrostatic Lubricated Bearings

M A KOENDERS. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 32 pp. $1.

A brief survey of developments leading to the conclusion that air bearings are feasible in a large range of applications. It is believed there is enough data for the experimental application

(Continued on page 117)

". . . then there's you, Haney . . ."

"Customeered" components basic to industry

ideas on "Customeered" RUBBER PARTS

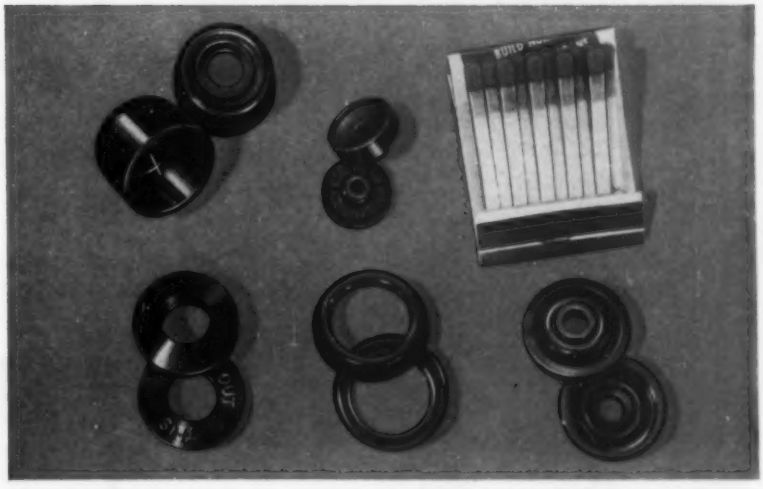
...their design and application for improved product performance — No. 1

New ORCO continuous process now custom molds precision rubber parts in volume—at less cost!

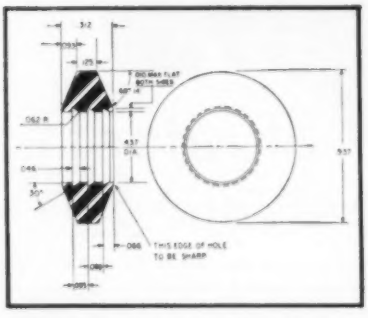
Precise tolerances within ±0.003 in. are now possible in large volume production of custom-molded rubber component parts. Ohio Rubber's new high-speed, continuous molding process produces such parts at rates of up to 200,000 pieces per day.

Greater precision, which results in important savings on finishing costs, is assured through use of single-cavity, self-registering molds. They permit accurate, uniform application of pressure to minimize flash—maintain consistent tolerances for all dimensions. Uniform material thickness is equally assured by a plasticizing mill, which as an integrated part of the process directs uniform charges to each mold.

Direct feeding, from the mill to the mold wheel, eliminates the conventional intermediate extrusion step and further insures part uniformity and quality consistent with specifications. The continuous process permits *precise* control of time and temperature for each part.



Wide range of parts being more economically produced through Ohio Rubber's new molding process include (top, left to right): valve stem deflector, condenser seal, (bottom) seal piston rod packing, universal joint seal, and oil seal. These, like all the many other small, precision parts already produced or being produced, vary in dimensions up to 1½" in diameter and 1" in thickness.



High-precision is indicated in the close tolerances of this quadruple-landed seal for auto shock absorbers—more economically produced in volume through Ohio Rubber's new high-speed, continuous molding process.

Large volume production results in substantial cost savings for small, precision parts requiring tolerances obtainable by other precision molding processes. For parts formed by less precise, conventional methods, performance can be improved through greater accuracy—and without prohibitive increase in cost.

Quantity requirements involving 500,000 or more parts annually are recommended for most advantageous use of the new process. Since two similar parts of different size can be produced simultaneously by alternating the molds on the molding wheel, lower production runs which might not be economical can be combined with a separate order.

Complete information on this revolutionary new process is available in bulletin form. Send for your free copy today. At the same time, be sure to inquire about Ohio Rubber's complete component "Customeering" service—molding, extruding, and bonding-to-metal. Just mention ORCO Bulletin 715.

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THE OHIO RUBBER COMPANY
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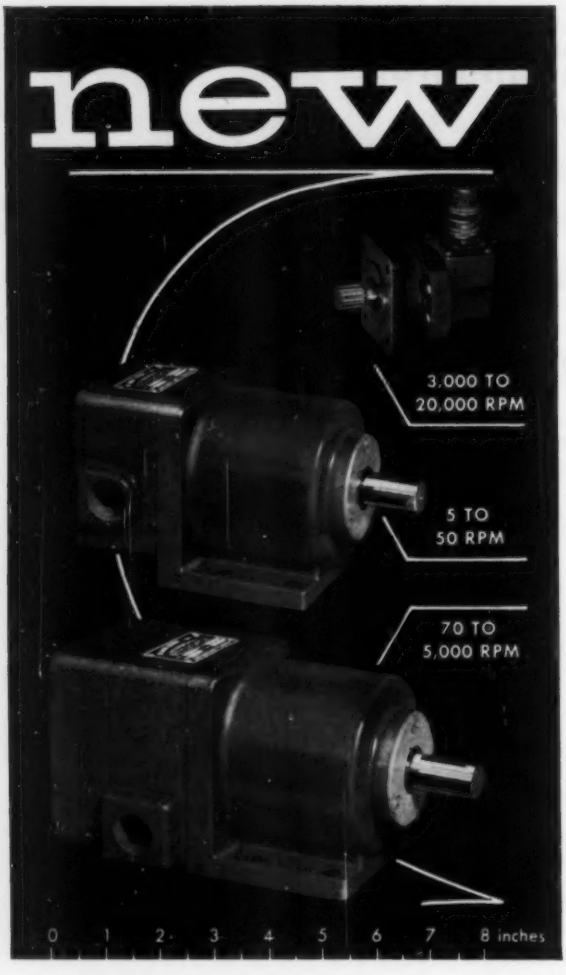

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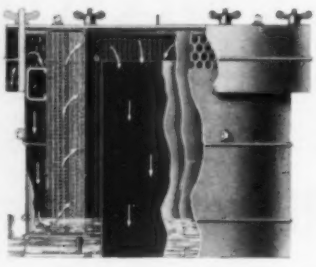
for engines, compressors and blowers



The Air-Maze Type F filter provides efficient removal of fine dirt from intake air to reduce wear on engine, compressor or blower parts.

High dirt removal efficiency is attained through its thorough scrubbing action. This scrubbing action is created by directing dirt-laden air into intimate contact with an oil pool. A "manometer" action created by the air passing a continuous baffle within the pool, causes more oil to be re-cycled than on other types of filter designs. Any dirt that remains in the air is then impinged on metal baffles. The metal baffles are kept clean by constant wash of the oil bath.

Flexible in design, the Type F filter can be furnished with top or bottom outlets, with or without relief valves to handle compressor unloading or line surges. Where noise reduction is a factor, the filter can be furnished with silencing chamber.

Available in sizes from 20 to 6650 cfm. Write Air-Maze Corporation, Cleveland 28, Ohio. Dept. PE-4.

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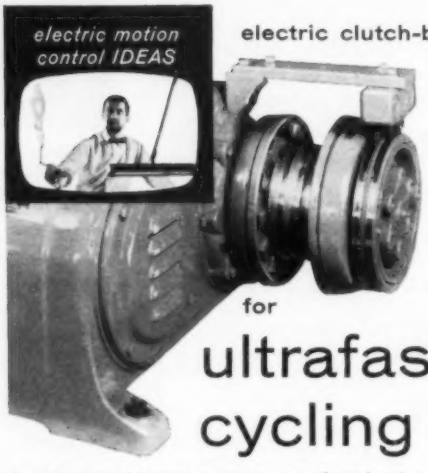

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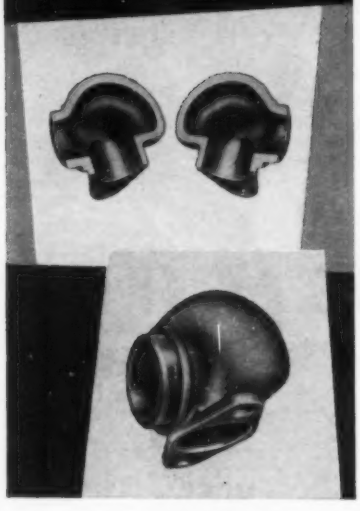
two halves *don't* make a hole!



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of hydrostatic bearings—although only references to data are given here. The report (Apex 390) also concludes that thrust bearings may be of either the hydrostatic or the hydrodynamic variety, depending on the speed of the rotor, and the load to be supported. For journal bearings the tendency is toward hydrostatic operation, although hydrodynamic operation has been achieved at high speeds. For low speeds, hydrostatic support is usual.

Other Books of Interest

Thermal Properties of Ceramics. *SMOKE and KOENIG. Engineering Research Bulletin #40, College of Engineering, New Brunswick, NJ. 53 pages, 5¼ x 8¼. 75¢.*

Effects of Radiation on Materials. *HARWOOD, HAUSNER, MORSE and RAUCH. Reinhold Publishing Corp, 430 Park Ave, NY 22. 355 pp, 6¼ x 9¼. $10.50.*

Symposium on Structural Sandwich Constructions. *ASTM Publication 201, American Society for Testing Materials, 1916 Race St, Philadelphia 3. 103 pp, 6¼ x 9¼. $2.75.*

Radiation Effects on Materials—Vol. 1. *ASTM Publication 208, American Society for Testing Materials, 1916 Race St, Philadelphia 3. 6¼ x 9¼, 190 pp. $4.75.*

Linear Polyethylene and Polypropylene: Problems and Opportunities. *G F DORIOT, Professor of Industrial Management, Harvard U. Polymer Associates, 6613 Wenonga Rd, Kansas City, Mo. 151 pp, 8⅜ x 10⅞. $13.50.*

Status of High-strength Steels for the Aircraft Industry. *NEKERVIS, LUND and HALL, PB 121639 (TML Report #91, Battelle Memorial Inst), Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 88 pp plus appendices. $2.75.*

(Continued on page 119)

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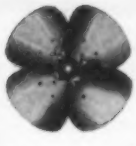

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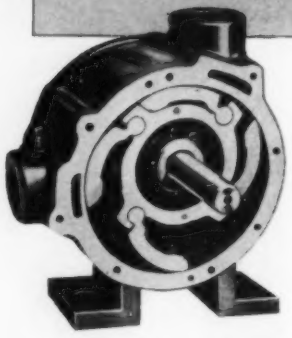

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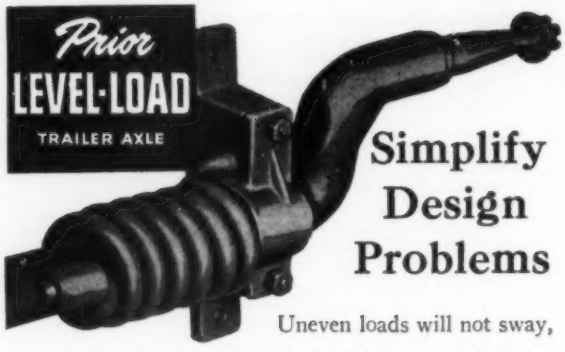

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Evaluation of Fatigue Properties of Titanium and Titanium Alloys. *WEINBERG and HANNA. PB 121631 (TML Report #77, Battelle Memorial Inst), Office of Technical Services, Dept of Commerce, Washington 25, DC. 8⅛ x 11, 26 pp plus appendices. $3.75.*

Properties of Titanium Alloys at Elevated Temperatures. *SCHWARTZBERG, HOLDEN, OGDEN and JAFFEE. PB 131634 (TML Report #82, Battelle Memorial Inst), Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 216 pp plus appendices. $6.*

Coated Abrasives. *Coated Abrasives Manufacturers' Institute. McGraw-Hill Book Co Inc, 330 W 42 St, NY 36. 426 pp, 6¼ x 9⅜. $8.50.*

Has some data on surface phenomena, finish criteria, operating suggestions, special considerations imposed by types of equipment and by materials being processed.

Current Reprints

While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

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Our forecast of what tomorrow's products will look like. May 4 *Circle E 78*

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Constructions, types, uses, and the advantages they offer. April 27 *Circle E 77*

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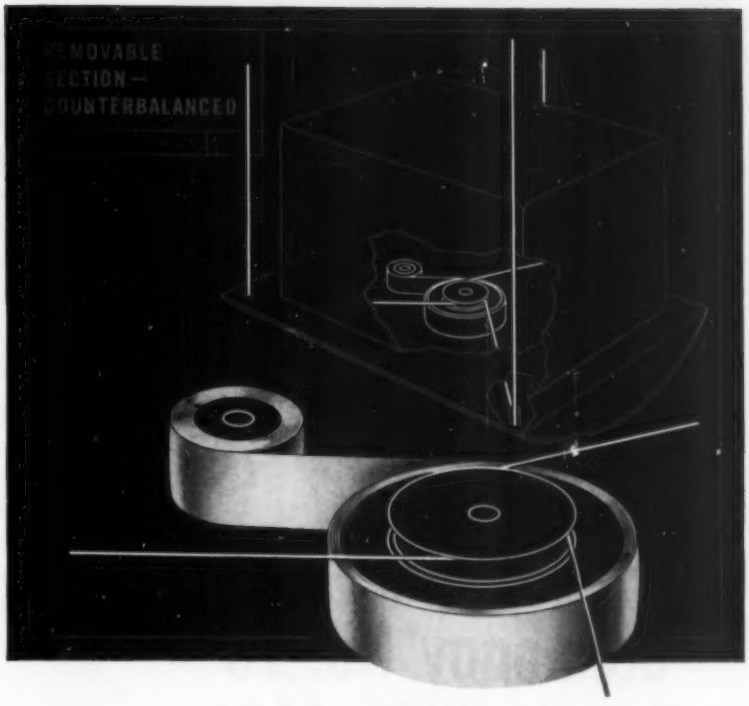
Method to read strain in actual structures and parts under load. March 2 *Circle E 70*

(Continued on page 121)



Counterbalance Without Mass

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Wind a NEG'ATOR constant-tension spring around a drum, then reverse-bend and wind the free end around a larger drum and you have a powerful, constant-torque motor.

Used as an internal counterbalance, for example, a NEG'ATOR motor offers unusual advantages over any other type of mechanism. Because it weighs only a small fraction of the force it exerts, this mechanical motor offers spectacular savings in overall weight and permits greatly simplified designs. Complete freedom is obtained in mounting and location. Working space becomes available. Massive external dead weights, tracks, guides, tubes, and complex linkages are eliminated.

The simplified illustration above resembles an actual application where a single NEG'ATOR motor with three cables on an output drum reel provides exactly balanced suspension of a 36 lb. aircraft gyro amplifier. Only a NEG'ATOR could perform this operation because of critical space and weight limitations. The gyro amplifier can be lowered as far as necessary below the fuselage for routine servicing. The entire counterbalancing unit, including NEG'ATOR, storage and output bushings, cable drum and fittings, occupies a space of only 8¼ in. x 5 in. x 2½ in.

This is just one of many such cases where NEG'ATORS in extension spring or motor form have provided *internal* counterbalancing for floating or assisting. Other such applications and details on NEG'ATOR springs are described in Bulletin 310N. Send for your copy.

*NEG'ATORS *is a registered trade mark of Hunter Spring Company.*

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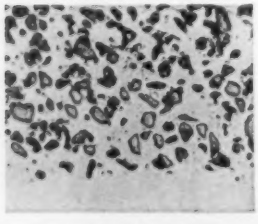

Photomicrograph (25X) shows the tungsten carbide and other smaller hard constituents dispersed in the nickel-base matrix. Relatively clear lower area is base metal. Tests prove Colmonoy No. 75 provides maximum carbide content consistent with good bearing quality, and with maximum deposit efficiency.

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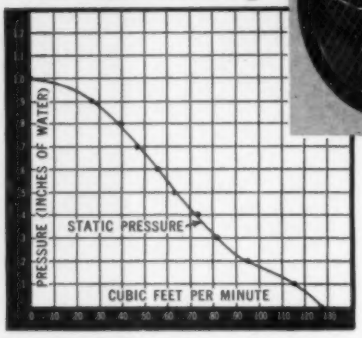

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Introducing the Space Crank

Variation of a 3-D mechanism that can replace various linkages and cams. March 2 *Circle E 69*

Stress Considerations for Safe Design

Graphical method determines safety factors when fluctuating loads are superposed on existing stresses. Feb 16 *Circle E 68*

When Air Is the Coolant

How to estimate whether the assembly will run too hot—and whether or not air can cool it. Feb 16 *Circle E 67*

For Faster Reading

Five steps to improve your reading speed—combined reprint of six-part article. *Circle E 66*

Linkages by Graphical Synthesis

Design of 4-bar linkages to generate specific functions. Feb 2 *Circle E 65*

Product Design at —300 F

Planning for products that must handle liquefied-air gases. Feb. 2 *Circle E 64*

Solution by Analogy

What makes analog computers different from digital types? Jan 26 *Circle E 63*

Roll Cams—Stop and Go on Demand

Graphical method for designing simple mechanisms that give a prescribed motion when triggered. Jan 19 *Circle E 62*

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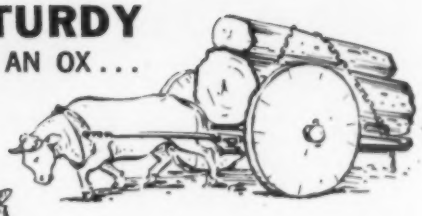

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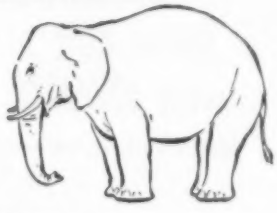

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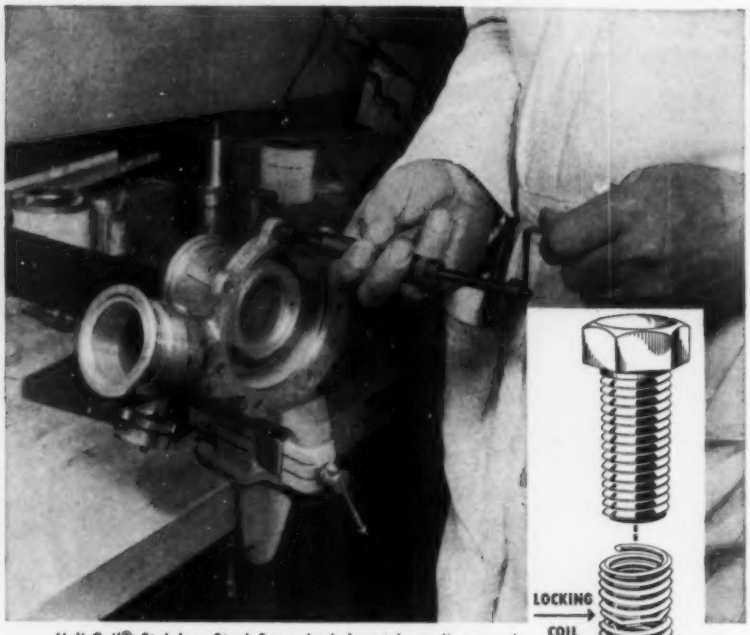

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To reduce weight in the refrigeration system designed for air conditioning the giant Douglas DC-8 Jetliner, Carrier engineers used aluminum alloy compressor castings. To obtain maximum performance and reliability of threaded connections exposed to heat and vibration encountered at 600 mph, they selected the *Heli-Coil* stainless steel wire thread, *internal locking* Screw-LOCK Insert.

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*Patented

HELI-COIL CORPORATION
DANBURY, CONNECTICUT

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Index of

PRODUCTS ADVERTISED

In This Issue

After reading the advertisements classified below . . . MORE DETAILED INFORMATION about these products can be obtained by using the READER SERVICE CARD.

A

Adhesives 100
Aluminum Alloys 14,-16, 74
Asbestos Material 6
Axles 118

B

Bars
Nonmetallic 94
Bearings
Ball 44, 85, 93
Roller .....4th Cover, 28, 44, 85
Bellows 89
Belts, Timing 111
Blowers 117, 120
Brakes
Electric 116
Bushings 37

C

Cam Followers 28
Carbon 38-39
Castings 105
Castings, Precision Investment..... 117
Ceramics 41
Chains
Conveyor 11, 111
Roller 11, 111
Clips 46
Closures 118
Clutches
Electrical 116
Mechanical 106
Coatings 112
Connectors
Hose 17-18, 77
Tube 17-18, 77
Contacts & Contact Materials..... 124
Controls
Electrical 86-87
Pneumatic 1
Conveyor Belts 72
Counters 106
Cylinders
Hydraulic 10

D

Die Castings 80-81, 98
Dies 90
Drives
Shaft-Mounted 95

E

Engineering Services (see also Production Services) 104
Extrusions
Nonmetallic 123

F

Fabricated Plastics (see Plastics, Fabricated)
Fastening Methods 32, 46, 83, 96
Fibre 35, 108
Filters
Air 79, 116
Fittings, Hose, Pipe & Tube.....17-18 106, 110

G

Gaskets 6
Gear Motors (see also Motor Reducers).....3rd Cover, 88, 114
Gears 4, 70, 82
Graphite 38-39

H

Hard Surfacing 120
Heating Units 107
Hose & Tubing..... 77

J

Joints
Universal 109

Index of

PRODUCTS ADVERTISED

In This Issue

L

Lamps, Indicator 103
Laminated Plastics (see Plastics, Laminated)
Liquid Level Controls..... 112

M

Moldings
  Plastics (see Plastic Parts)
  Powdered Metal (see Powdered Metal Parts)
  Rubber (see Rubber Parts)
Motor Reducers (see also Gear Motors) 95
Motor Starters 86-87
Motors, A-C
  Sub-Fractional 92

N

Nickel Alloys 2, 101
Nuts 32

P

Photographic Equipment
  Film 67
Plastic Parts 104
Plastics 12-13
Plastics Fabricated 94
Plastics Laminated 108
Powdered Metal Parts.....38-39
Production Machines & Processes.... 107
Protective Devices, Motor..... 8-9
Pumps
  Air 118
  Liquid 10, 118, 121

R

Relays 126
Reproduction Equipment..... 113
Reproduction Supplies 67, 113
Resins 97
Rivets 32, 96, 107
Rods
  Nonmetallic 94
Rubber 37, 115
Rubber-Bonded-to-Metal 37
Rubber Parts 110, 115, 123

S

Screw Fasteners 96, 122
Screw Thread Inserts..... 122
Seals .....2nd Cover, 106
Sheets
  Metal 27
  Plastic 94
Silicone Rubber 33-34
Silicones 33-34
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.) .32, 46
Speed Increasers & Reducers.....82, 114
Spindles 102
Springs 30-31, 119, 124
Sprockets 11
Steel
  Alloy 2
  Stainless 27
Strip, Metallic 27
Switches 116

T

Terminals & Terminal Boards..... 78
Thermostats 40
Tracing Cloth 67
Tracing Paper 29, 67
Tubing
  Flexible Metal 77
  Plastic 94
  Seamless 36

V

Valves
  Air 1, 17-18, 99, 102, 125
  Control 125
  Hydraulic 10, 102, 125
  Solenoid 99

W

Wire 42-43
Wire Cloth 84

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PRECISION GROUND

Channels or chicken pluckers . . . washers or weatherstrips . . . you name it and we'll make it! And we'll produce it to meet your most precise design specifications! Stalwart offers you a complete rubber parts *service* . . . Rubber Engineers develop your special compound from natural, synthetic or silicone rubbers . . . Laboratory Technicians pre-test actual performance . . . our own completely equipped Tooling Department produces the necessary extrusion dies . . . skilled Production Personnel operate the latest rubber machinery for maximum economy, dependable delivery . . . and *our* Quality Control Department protects *your* interests! This means you get higher quality at a lower cost . . . the result of nearly 40 years of fabricating experience! To solve tough rubber parts problems . . . cut assembly costs, *specify Stalwart.*

Write today for complete information.
Ask for your copy of Stalwart Catalog SR-59.

STALWART RUBBER COMPANY

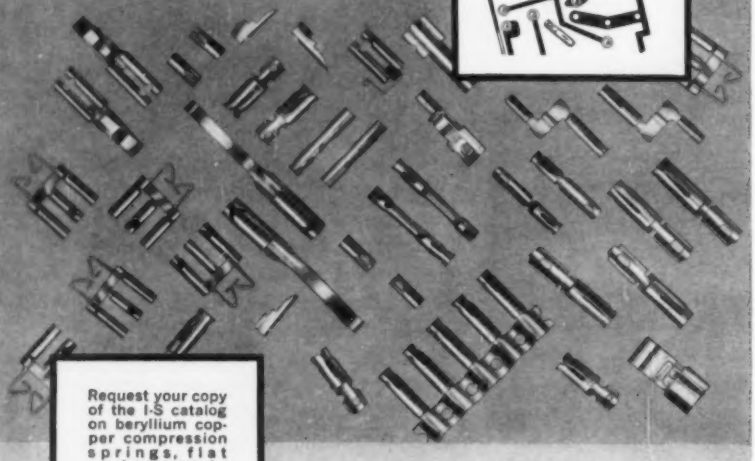
166 Northfield Road • Bedford, Ohio
Manufacturing facilities in
Jasper, Georgia and Bedford, Ohio

MICRO-PROCESSED FOR COMPLETE RELIABILITY

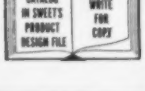
I-S beryllium copper electrical contacts

- Excellent Electrical Characteristics
- Precision Accuracy
- Freedom from Fatigue
- High Efficiency at Elevated Temperatures
- Corrosion Resistance
- Uniform Quality

Increase Dependability of Your Miniature Sockets and Terminal Boards



Request your copy of the I-S catalog on beryllium copper compression springs, flat springs, strip springs, contact strips, contact rings and screw machine parts. Send drawings and specifications for quotations on your specific requirements.



I-S Beryllium Copper contacts provide important advantages both electrically and mechanically. They offer designers and engineers the increased reliability required for today's most critical applications. Custom made contact springs of the types illustrated are produced economically in large quantities by means of automatic tooling. I-S engineers are available to help work out your contact problems and will gladly make recommendations on receipt of your application data; no obligations.

INSTRUMENT SPECIALTIES CO • INC

234 Bergen Blvd., Little Falls, N. J.
Telephone: CLifford 6-3500

"MICRO ...PROCESSED" I-S BERYLLIUM COPPER SPRINGS

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

AMP, Inc. 78
Aetna Ball & Roller Bearing Co., Div., Parkersburg-Aetna Corp. 85
Air-Maze Corp. 116
American Lava Corp., Subs., Minnesota Mining & Mfg. Co. 41
American Metal Hose Div., American Brass Co. 77
Anchor Coupling Co., Inc. 110
Armstrong Cork Co. 6
Arrow-Hart & Hegeman Electric Co. 86-87
Associated Spring Corp. 30-31

B/W Controller Corp. 112
Barden Corp., The 93
Blaw-Knox Co., Foundry & Mill Machinery Div. 105
Boston Gear Works 70

Cambridge Wire Cloth Co. 84
Chemical Products Corp. 112
Chicago Molded Products Corp., Custom Molding Div. 104
Chicago Rawhide Mfg. Co. ..... 2nd Cover
Clark Controller Co. 126
Clearprint Paper Co. 29
Clover Industries, Inc. 118
Commercial Shearing & Stamping Co. 10
Cone-Drive Gears Div., Michigan Tool Co. 88
Continental Diamond Fibre Co., Subs., Budd Co. 108
Crane Packing Co. 91

Dayton Rubber Co., Industrial O.E.M. Div. 37
Doehler-Jarvis Div., National Lead Co. 80-81
Dow Chemical Co. 12-13
Dow Corning Corp. 33-34
Driver-Harris Co. 101
du Pont de Nemours & Co., (Inc.), E. I., Textile Fibers Dept. 35

Eastern Air Devices, Inc. 120
Euclid Electric & Mfg. Co. 116

Fairbanks Co. 106
Fairbanks, Morse & Co., Magneto Div. 106
Falk Corp. 95
Fenwal, Inc. 40
Firestone Steel Products Co., Div., Firestone Tire & Rubber Co. 74
Flexonics Corp., Bellows Div. 89

Gear Grinding Machine Co., Joint Div. 109
Gear Specialties, Inc. 4
General Electric Co., Miniature Lamp Dept. 103
General Industries Co. 92
Goodrich & Co., B. F. 32
Gries Reproducer Corp. 98

Heli-Coil Corp. 122
Hitchiner Mfg. Co., Inc. 117
Horsburgh & Scott Co. 82
Hunter Spring Corp. 119

Instrument Specialties Co., Inc. 124
International Nickel Co., Inc. 2
Intimex Corp. 106

Janette Electric Mfg. Co. 114

Kaiser Aluminum & Chemical Corp. 14-16
Keuffel & Esser Co. 67

Lamina Dies & Tools, Inc. 90
Leiman Brothers, Inc. 118
Lepel High Frequency Laboratories, Inc. 107
Link-Belt Co. 11, 44

McGill Mfg. Co., Inc. 28
McLouth Steel Corp. 27
Mechanical Air Controls, Inc. 99
Metals & Controls Corp., Spencer Thermostat Div. 8-9

INDEX TO ADVERTISERS

Michigan Tool Co., Cone-Drive Gears Div. 88
Milford Rivet & Machine Co. 107
Morse Chain Co., A Borg-Warner Industry 111

National Standard Co. 42-43
National Tube Div., U. S. Steel Corp. .. 36
Norgren Co., C. A. 79

Ohio Rubber Co. 115

Parker Fittings & Hose Div., Parker-Hannifin Corp. 17-18
Parker-Hannifin Corp., Parker Fittings & Hose Div. 17-18
Post Co., Frederick 113
Prior Products, Inc. 118

Reliance Electric & Engineering Co. ..... 3rd Cover
Republic Mfg. Co. 102
Revcor, Inc. 117
Ross Operating Valve Co. 1
Rubber & Asbestos Corp. 100
Ruthman Machinery Co. 121

Shakeproof Div., Illinois Tool Works .. 83
South Chester Corp., Southco Div. 96
Stalwart Rubber Co. 123
Standard Electrical Tool Co., Precision Spindle Div. 102

Thiokol Chemical Corp. 97
Timken Roller Bearing Co. ..... 4th Cover
Tinnerman Products, Inc. 46

U. S. Gasket Co., Subs., Garlock Packing Co. 94
U. S. Graphite Co. 38-39
U. S. Rubber Co., Mechanical Goods Div. 72

Wall Colmonoy Corp. 120
Warner Electric Brake & Clutch Co. .. 116
Western Rubber Co. 110
Westinghouse Air Brake Co., Industrial Products Div. 125

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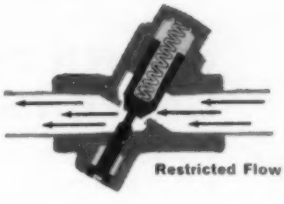
CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 120
Index to Advertisers begins on P 124
Products Index begins on P 122

New Westinghouse FLOREG Valves for accurate flow control of gases and liquids


Restricted Flow

Free Flow

The new Westinghouse Floreg Valve accurately controls the rate at which a gas or liquid can flow in one direction through the circuit, yet allows free flow in the opposite direction. It works with other components of a fluid circuit to time, to sequence or to co-ordinate the operations of the circuit.

Chief Advantages

Easily adjustable in minute steps to full flow.

Greater capacity, lightweight and compact.

Consistent flow regulation: Single flow passage eliminates leakage encountered in separate check valve design.

Corrosion resistant: Made of aluminum, stainless steel and plated steel parts. Seals are oil-resistant.

Working pressure: 250 psi maximum pneumatic, 500 or 2000 psi maximum hydraulic.

Easily inspected and maintained: No need to break circuit connection.

Operating temperature range: —40 ° to 200 ° F.

Three sizes: ¼", ⅜", and ½", N.P.T.

Prices start at $4.00 on the ¼" size weighing 2.5 ounces.

Applications

. . . In the delivery line to a cylinder to control its piston speed.

. . . In material processing to time operations.

. . . In material handling to co-ordinate movement.

. . . In the speed line of a diesel engine to control acceleration rate.

See the yellow pages under cylinders for the name of your local distributor

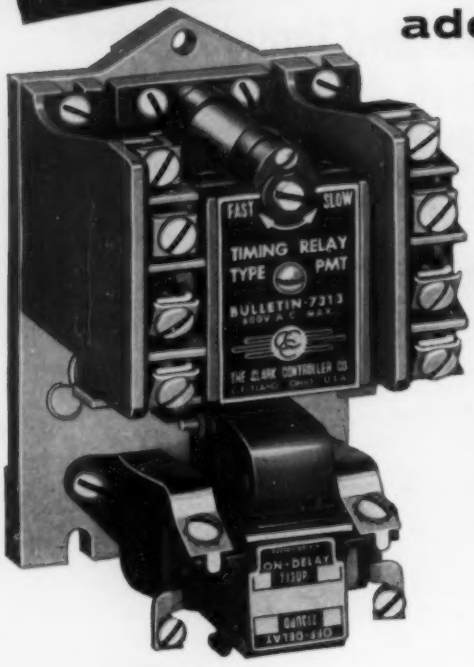
WESTINGHOUSE AIR BRAKE COMPANY
Industrial Products Division, Wilmerding, Pennsylvania

NEW!

SPACE-SAVING

TWO CLARK RELAYS

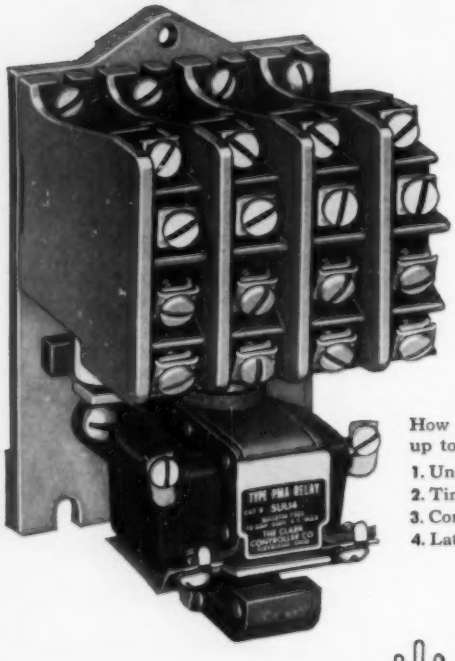
added to the "PM" Line!...



With the addition of *Time-Delay* and *Universal Pole* Relays to its "PM" line, Clark now offers *the most complete integrated line of control relays available today!* They have the same "modular" design and match physically the Convertible Pole (Type "PM") and Latch Relay (Type "PML").

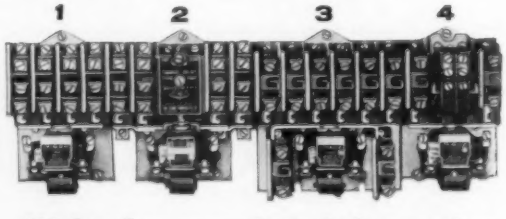
CLARK Type "PMT" TIME DELAY RELAYS

- Line up with other relays in the "PM" line.
- Timing head occupies space of 2 poles above magnet.
- Poles are "universal" type—each with 2 isolated contacts, one normally open, one normally closed, same as used on "PMA" relays described below.
- Available for "ON-DELAY" or "OFF-DELAY" operation (time delay after energization or de-energization). Easily convertible in the field.
- Timed and instantaneous poles are identical.
- Models available with either 2 or 4 timed contacts and up to 6 instantaneous contacts.



CLARK Type "PMA" UNIVERSAL POLE RELAYS

- Line up with other relays in the "PM" line.
- Each pole contains 2 isolated contacts—one normally open, one normally closed, with 600v clearance between contacts.
- Individual poles can be removed or replaced without disturbing others. Each pole has its own arcing chamber—any short circuit is confined to one pole.
- Poles are interchangeable with convertible poles of "PM" relays.
- Models available with up to 14 contacts per relay.



How Clark Relays line up to save panel space.

1. Universal Pole Relay
2. Time Delay Relay
3. Convertible Pole Relay
4. Latch Relay

Write for complete information

The CLARK CONTROLLER Company

Everything Under Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

buy your horsepower at the output shaft

Speed reducer problems involve more than just gear ratios. Horsepower, torque, overhung loads and duty cycle are considerations that require performance matching of motor and reducer. When you specify Master Gearmotors you eliminate dual responsibility for overall performance.

Master Gearmotors are packaged components, engineered to meet your requirements from line voltage to keyway dimensions. Motor and reducer are built as a single, rigidly aligned unit. These compact drives offer maximum efficiency and durability at minimum cost.

You can reduce engineering and assembly expenses by giving Master the responsibility for the entire power package. With Master Gearmotors you buy your horsepower where you need it, at the output shaft.

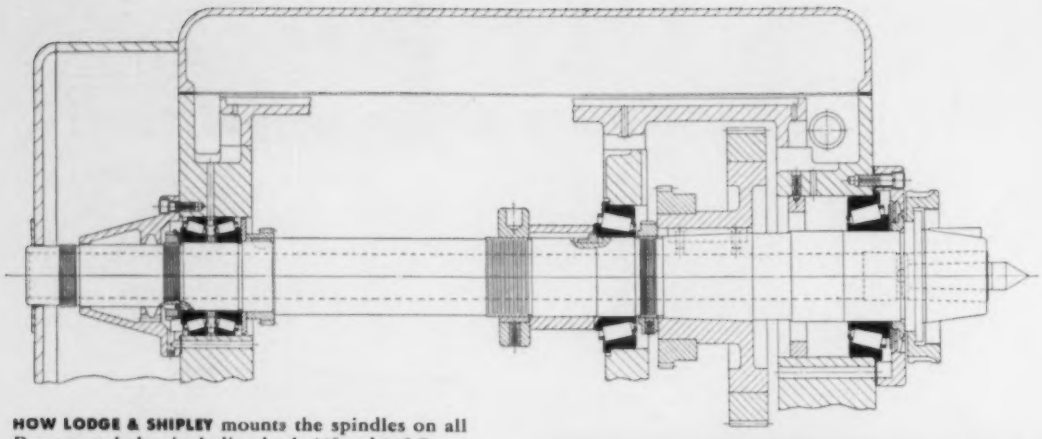
Vertical and horizontal, right angle and parallel shaft, worm, helical and herringbone gearing—⅛ thru 125 hp.

Product of Master Electric Division of Reliance Electric and Engineering Company, manufacturers of a-c. motors, Reeves Drives, V★S Drives, Super 'T', D-c. Motors, generators, controls, and engineered drive systems. E1609

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 304A, CLEVELAND 17, OHIO
CANADIAN DIVISION: TORONTO, ONTARIO
Sales Offices and Distributors in Principal Cities

MASTER R REEVES



HOW LODGE & SHIPLEY mounts the spindles on all Powerturn lathes including both 45° and 90° Copymatics on Timken bearings to get extra rigidity, maintain accuracy, reduce maintenance.

New type lathe ups production 200%, saves users an estimated $8,000 a year

...one secret—TIMKEN® bearings on the spindle

"Production increases as high as 200%"..."Overall savings estimated at $8,000 a year"—read user reports about the new Powerturn 90° Copymatic Lathe. One important reason for such exceptional results is that Lodge & Shipley mounts the spindle on Timken® tapered roller bearings. Timken bearings give it the vital extra rigidity and hold runout to the minimum needed for tracer accuracy.

How spindle is held rigid. Timken bearings hold the spindle in positive alignment. They take *both* radial and thrust loads in any combination, because of their tapered design. And because of full line contact between rollers and races, Timken bearings have extra load-carrying capacity.

Why heavy shocks are absorbed. Case-carburization of Timken bearings' rollers and races gives them hard, wear-resistant surfaces and tough, shock-resistant cores.

How friction is virtually eliminated. Timken bearings are geometrically designed to roll true. And they're precision-made to live up to their design. They run smoother—last longer.

We even make our own electric furnace fine alloy steel, for extra quality control. We're America's only bearing maker that does. To get all these advantages, always specify bearings trade-marked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD